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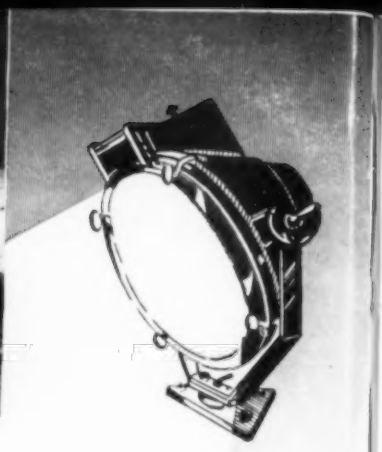

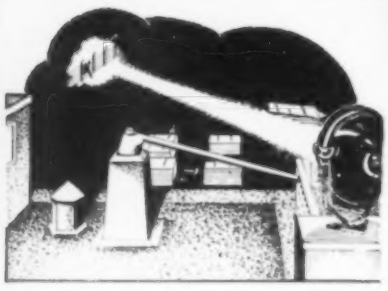

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The articles in this Journal are indexed in the *Reader's Guide to Periodical Literature* which may be found in any public library.

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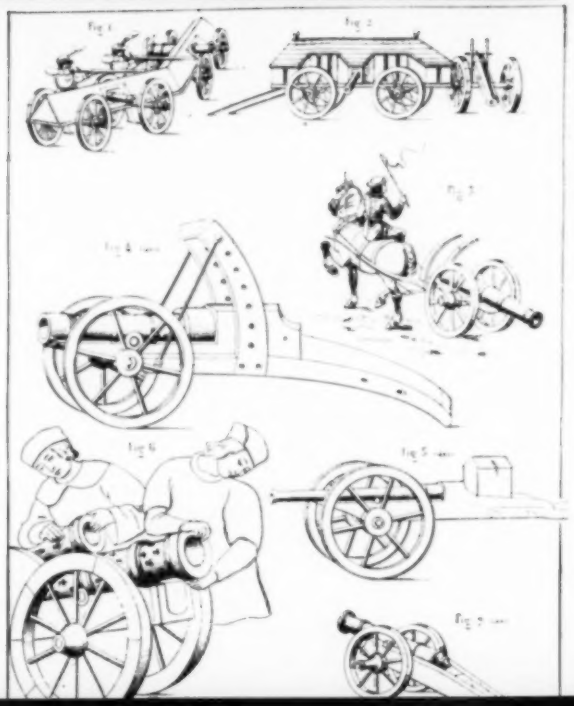
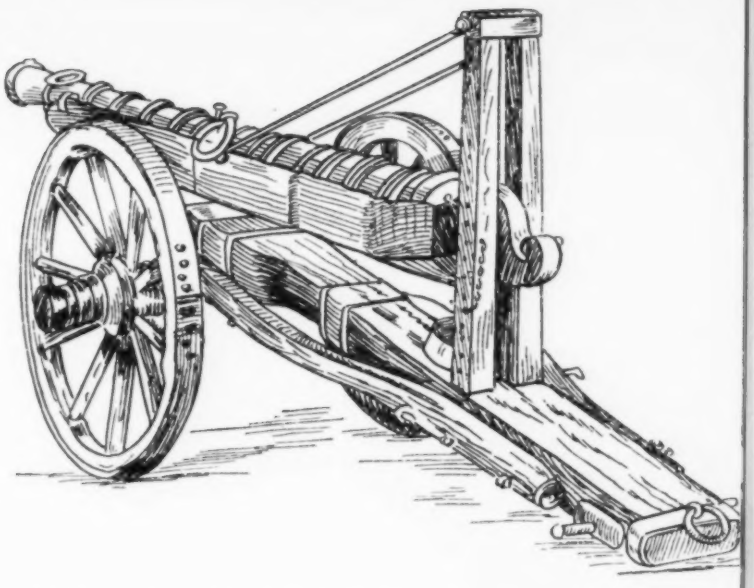
Breechloading wall cannon, 14th century



Cast cannon of the 15th century

(Courtesy *Handbook of American Coast Artillery Matériel*)



Early type of carriage, 16th century

(Courtesy *Textbook of Gun Carriages and Gun Mountings, 1924*)

GUNS — AND CANADA

by **A. G. CAMPBELL***

ARTILLERY of all the various kinds developed to date would appear to have evolved from the proven discovery of gunpowder somewhere in the 13th century; that is to say, since gunpowder came into common use as a propellant force in missiles.

Research shows that gunpowder, of a sort, was in use as early as the 6th century in which times a besieged city was bombarded by mechanical contrivances which lobbed balls containing powder, pitch, etc. over the defending walls (very similar to our present-day trench mortar, though probably much larger).

In the 7th and 8th centuries, the most formidable weapon then known was and still is referred to as "Greek Fire", the parent, apparently, of the liquid fire weapons used in the last war. Details of the Greek weapon are not available, but that it was a most devastating implement can be gauged from the fact that when in A.D. 716 to 718 the Arabs for the second time attacked Constantinople with 1,800 ships, only five returned to their home port. It would appear that "Greek Fire" was discharged from long tubes and the incendiary constituents, which were ignited on discharge, comprised naphtha, sulphur and pitch. It is probable, also, that solid incendiary material of the same composition was fired from the tubes. The mechanical projecting device, whatever it was, probably used gunpowder of some kind as a propellant and must have had quite a long range to have caused such tremendous damage to ships.

Cannon using a propellant charge of black powder were in use from the 13th to the 16th century. A solid ball was discharged to more or less erratic distances, and in the earliest times the bursting of the iron or bronze cannon under the pressure developed in the barrel was a common occurrence.

The first authentic record of the use of guns was by the English at the battle of Crecy in 1346.

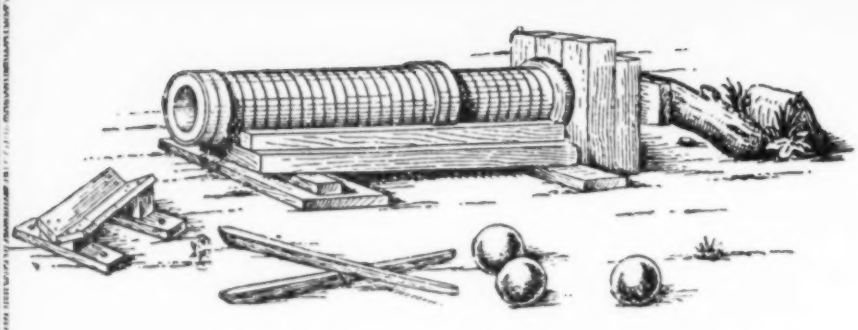
Around the 17th century, the practice of filling the gun with a loose powder propellant charge was discarded and paper containers, the progenitor of our present cartridge cases, were first used. Metal cartridge cases were not used until the 18th century.

From the earliest records of the use of firearms and for a subsequent period of some 600 years, black powder was the sole propellant used. Around 1850, experiments were made with guncotton, ordinary cotton treated with acids, and from these experiments eventually came the presently-used cordite, a mixture of guncotton and nitroglycerin.

The stupendous propellant force of cordite, when ignited in a confined space, will be realized when it is considered that a large naval or land gun can project a shell weighing one ton for a distance of 18 miles with an amazing degree of accuracy. Or again, present-day anti-aircraft guns can project a 28-pound shell a distance of eight miles in the air.

The developments of the guns themselves, or cannon from the Latin "canna" (i.e. a tube), would appear to be divided into three periods. The first period extends from 1250 to about 1500, during which time the projectiles were first arrows and later stones, the weight of the latter constantly being increased until, in exceptional cases, they reached a weight of a

*Assistant Chief, Army Gun Production Division, Department of Munitions and Supply, Ottawa



Wrought-iron gun on crude plank carriage, 14th century

(Courtesy *Handbook of American Coast Artillery Matériel*)

ton each. The cannon were made of iron, but to obviate the frequent bursting under pressure, they were made tremendously large compared to the then comparatively small projectile and range attained.

An exaggerated instance of the size of these guns is the famous one used by Mohamet II at the siege of Constantinople in 1453. This was a brass cannon with a bore of 36 inches. It was so heavy that it required a carriage of 30 waggons linked together and took a team of 60 oxen to draw it. Two hundred men had to march beside it to steady the gun during transit and it took 250 workmen moving ahead to prepare the roads in advance. It is recorded that it took two months to move this cannon a distance of 150 miles.

From 1500 to approximately 1850, all projectiles were round metal shot and shell, and up to this time all cannon were smooth bored, with very little change in principle; indeed, the gun of 1800 was merely the gun of 1400 multiplied more than a hundred times in weight.

Rifles were introduced into the French Army around 1800, but were withdrawn by Napoleon owing to the great time taken for reloading, and armies in general relied on the single-shot musket. It has been estimated that with musket firing, only one out of each 500 bullets hit its intended target in wartime.

The British Army discarded muskets and adopted rifles in 1860, and the French re-adopted them in 1870. It seems difficult to understand the delay in equipping armies with rifles, as ever since 1800 the rifle had secured far more excellent results than the army musket.

Revolvers date back to 1540, but were simple one-shot pieces. Later, revolvers were produced with several barrels rotating around a central spindle. The Colt revolver of 1835 was the first practical single barrel weapon.

Hand grenades date from the 15th century. "Grenadiers" were first formed by the French in 1667. The first rifle grenade came into being about 1900.

The use of firearms was responsible for the rising ascendancy of infantry over cavalry, and this superiority became more pronounced in the early sixteen hundreds when firearms became both effective and mobile.

The origin of machine guns would appear to be a development of a primitive idea whereby a number of muskets were mounted alongside each other in a frame on a wheeled carriage from which protruded spears, intended as a protection for the gunners from frontal attack. This was called an "organ gun". The machine gun, as we know it, was first produced in 1718 and consisted of a revolving block containing seven or nine chambers. Until the system of breechloading was well advanced, the utility of this machine gun was limited to defence, owing to the length of time required for loading from the muzzle.

The first effective breechloading machine gun was the Gatling of 1862 vintage, although this attracted little attention, principally owing to the frequent jamming of the gun. Rate of fire was about 350 shots per minute. This will compare with the present-day machine guns which will fire 1,200 shots per minute and which have reached a state of mechanical perfection that allows for a few machine guns to replace the firing power of a battalion of infantry and which, when mounted eight and twelve in an aeroplane can produce such devastating results on open formations of infantry, and destroy opposing aeroplanes by literally cutting them to pieces by a single burst of fire from its combined eight or twelve guns.

From 1850 onwards, the necessity of rifling both cannon and small arms was recognized. Rifling, which consists of cutting small parallel grooves on the inside and length of the barrel, has the effect of rotating the projectile, thus attaining a more accurate trajectory and keeping the missile in flight, nose first. Previous rifling experiments were discontinued owing to the continued bursting of the barrel under pressure, which for some reason was associated with the rifling.

Various other improvements took place from 1850 onwards, such as the substitu-

tion of spherical shot by cylindrical projectiles, the use of steel instead of cast or wrought iron, and the principle of building a gun of separate components, instead of a one-piece affair.

The 19th century saw the development of cannon from wrought iron and carbon steel until we have the present-day alloy steel. Breechloading was finally adopted in its entirety, as compared to the former muzzleloading. Breech mechanisms were perfected to the point of preventing the escape of gases to the rear of the gun, thus obviating in a large measure the bursting of the gun. Muzzle velocities per second were doubled. Black powder passed and smokeless powder came into use. High explosive and armour piercing shells were introduced. Projectiles were more or less streamlined and the rotation of the shell was much improved, with a great increase in the accuracy of fire.

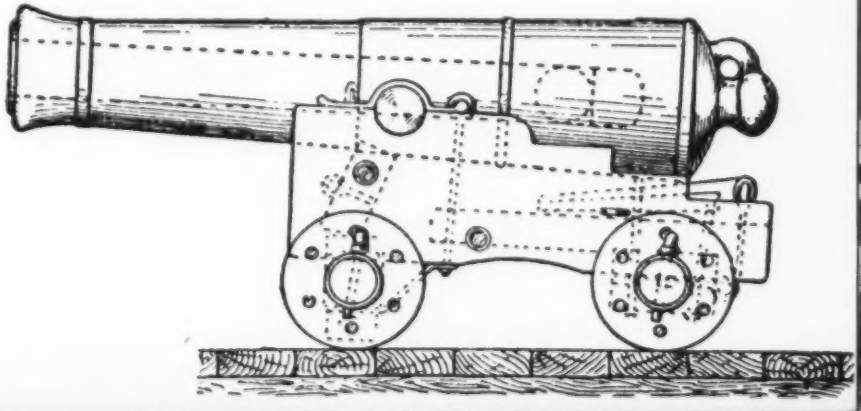
Gun carriages naturally had a later development than the ordnance. In the earliest days, the gun was simply placed on a mound of earth to give elevation, with a wooden stick at the rear to prevent the recoil. Around the 13th century, small guns were strapped onto a beam of wood. This beam was called a cradle, which term is still in use to denote that part of the carriage supporting the gun. Elevation was obtained merely by placing a piece of wood under the barrel. Wheeled and truck mounts of varying types for guns were used up to 1850, and until this date the same guns, carriages and ammunition were used indiscriminately on ships of war, coast fortifications and field artillery.

As the need arose, improvements were made on the carriages to meet the then existing requirements, and around 1900 the disappearing carriage came into being, designed to protect the gunners in fortifications from rifle men. After firing, the force of the recoil of the gun depressed the breech to a point below the top of the walls, where it was automatically secured by a catch, reloaded by the gunners, now protected by the walls; the catch was then released and the gun automatically elevated to firing position. With but very few exceptions this disappearing carriage has passed out of favour, and from 1900 onwards the development of separate carriages and mountings grew until we have the extremely complicated mechanism of to-day.

It is not possible in this short article to give details of carriage developments such as elevating gear, recoil systems and sighting arrangements. It is obvious, however, that with the rapid firing of modern guns, carriages would have to be so designed as to withstand the tremendous shock of the recoil and also to ensure the stability of the complete unit. Without the highly specialized recoil systems now in operation, the guns would move so far out of line that it would take a team of men to put them back into their original firing position after every round. Suffice it to say that the recoil systems of modern carriages demand the utmost of engineering skill of design and workmanship.

A recoil system for a heavy gun of to-day will weigh many tons and will absorb thousands of man-hours in the manufacture of one unit.

For many many years there was no need of sighting arrangements. The gun was merely put into position and the objective, usually defending walls, was battered until a breach was made. About 1550 a crude gunners' quadrant was invented which, when combined with the simple angles obtained therefrom, plus the weight of powder and shell, gave an approximate elevation for the gun, allowing the gunner to aim somewhere near the target. Through the years, great improvements in sighting have taken place, until to-day, especially with heavy artillery firing at unseen targets and, indeed, even at visible objects, it would appear that with a combination of telescopic sighting and high mathematical



Old type ship and coast gun and carriage, 17th century

Courtesy *Handbook of American Coast Artillery Matériel*

calculations, every gunner is a serious rival to Einstein himself.

It is safe to assume that the most radical changes and development of ideas in artillery have occurred during the past 30 years, a corollary of the revolutionary tactics of present-day warfare. Previous orthodox ideas of intense artillery bombardment preceding massed infantry advances now take second place to the great firing power and mobility of tanks, aided by massed aeroplane attacks. Tanks have formidable armament, including cannon, machine guns, smoke bombs, sub-machine guns, etc. and the striking power of aeroplanes with cannon, bombs and machine guns is now well known.

To combat this new form of warfare, new types of guns had to be evolved; hence we find anti-tank rifles and anti-tank guns. The former are used by advanced infantry and fire an armour piercing shot of .55 calibre, compared to the ordinary .303 ammunition and are an effective weapon at close range against light armoured cars.

Anti-tank guns mounted on rubber wheeled carriages constitute a very effective opposition to tanks. With a working range of 500 yards a shell can pierce armour plating 2½ inches thick, firing at a working speed of 25 rounds per minute. Lighter anti-tank guns with slightly less penetrating power are used for attacks on less heavily armoured transport cars.

Ordinary field artillery has also been used as an anti-tank weapon. In the Middle East the 25-pounder gun, which replaced the 18-pounder of the last war, has done splendid work in breaking up tank attacks. This piece can fire 15 rounds per minute, and its accuracy can best be described by the loving words of an artillery instructor who declares that with a 25-pounder he can split a 10-inch nail at 10,000 yards.

Most interest now centres on the wonderful anti-aircraft guns, produced to beat off mass aeroplane attack. These guns can be divided into the heavy and light sections. Heavy A. A. guns, such as the famous 3.7" British gun, are primarily used to drive attacking planes to such heights as to render accurate bombing impossible. These guns can fire a 25-pound shell to a distance of approximately seven miles in the air at a rate of 18 rounds per minute.

The Bofors light anti-aircraft gun is designed to cope with low-flying and dive-bombing planes. This marvellous gun, with its automatic loading arrangement, fires a shell weighing two pounds to an effective range of 10,000 to 15,000 feet at the amazing rate of 130 per minute with astonishing accuracy. The purposes of the above two A.A. guns can best be described by saying that a sufficiency of the heavy 3.7" can defend a town, but the Bofors makes an ideal defence of a particular place in a town. The intricate nature of these two guns can be realized when it is stated that each gun and mounting comprises approximately 2,000 parts, all machined to fine tolerances and requiring the best workmanship for assembly and to pass the rigid tests of service conditions.

All anti-aircraft gun mountings provide not only for high angles of elevation but also allow for angles of depression in mountainous country.

The use of aircraft has extended the problems of gunnery and introduces a situation where the gun has to engage a very fast travelling target.

In order to arrange for the shell from the gun to arrive at a previously determined spot, some miles up in the air, at the exact instant the hostile plane arrives at the same spot, many intricate computations have to be made at great speed. These include height, speed, the azimuth, i.e. the arc of the horizon measured clockwise (from 12 to 6), angular deflection, the influence of wind, air temperature, barometric pressure and humidity, together with the temperature of the gun propellant and the muzzle velocity of the gun.

With scientific development to-day there have been evolved amazing instruments called predictors, which work out all these problems without human aid, and these results are transmitted electrically to the gun. The direction of the gun is operated by a power unit control from the predictor with the result that with this system, known as remote control, the only operatives required at the gun itself are the ammunition loaders. Even the fuse is set automatically to detonate at a specified moment.

The astounding performances of these instruments can be gauged when one considers that the target may travel two miles or more during the flight of the shell. Added to which is the fact that the predictor will function before the target is visible to the human eye, picking up the wave emanations from the plane long before it is actually in sight.

Anti-tank guns are being turned out in large quantities; one of the types now being built in Canada.

Reference must also be made to the quadruple mounted anti-aircraft guns, known as "pom-poms", with which naval vessels are equipped. These batteries of four guns fire a 2-pound shell each at the rate of 120 rounds per minute with an effective range of 20,000 feet, and the concentrated fire of nearly 500 shells per minute constitutes a suicide curtain to dive bombers who must flatten out in that barrage area for a few seconds before loosing their bombs at a vessel.

The present war, so far, has not produced many changes from the field artillery, howitzers or trench mortars used in the last war, but mention should be made of a few figures appertaining to large naval guns.

This type of gun will weigh about 120 tons and with the unbelievably complicated mounting the total weight would be in the neighbourhood of 500 tons. The barrel would be at least 65 feet long and is built to withstand a pressure of no less than 45,000 pounds to the square inch. In order to withstand this pressure the barrel is bound with wire put on at a "pull" pressure of 5,000 pounds. Over 150 miles of wiring is used for one barrel. The gun fires an armour piercing shell weighing over one ton to a distance of 18 miles with amazing accuracy.

From the foregoing résumé, necessarily restricted, of the history of guns from birth to the present time, let us now take a brief glimpse at what the writer considers to be the amazing achievement of this Canada of ours in a field of engineering and mechanical skill demanding the highest standards of efficiency and workmanship.

Previous to this war Canada had never manufactured any weapons of war with the exception of the Ross rifle produced in the last war. Empty shells were produced and shipped to England, but this article is not concerned with munitions other than actual guns. Of these weapons, Canada, at the outbreak of war in 1939, had no knowledge whatsoever. The intensely complicated designs, the multifarious parts that were contained in a single unit, the extreme tolerances, in many instances down to a ten-thousandth part of an inch, that had to be rigidly adhered to, the metallurgical skill required for the specially selected materials necessary to stand the rigorous conditions of modern warfare,

Hon. C. D. Howe, Minister of Munitions and Supply, inspecting the first cruiser tank completed in Canada, and fitted with Canadian made guns.

the supply of huge and expensive machine tools costing up to $50,000 each; all these and many other things were unknown to Canada. Little wonder, therefore, that at the outbreak of war orders from Britain were confined to ammunition which Canada did know how to make, and to a very small quantity of loose barrels for anti-aircraft guns. No great store was at first set upon these orders for barrels, and it did not seem to be much of a contribution to a total war effort, but it must be remembered that the making of guns had been built up through many many years of intensified effort and research by the great manufacturing countries of the world.

The barrels first made by Canada were of such excellence of manufacture that consideration was then given to the making of guns themselves, and an initial order was received from Great Britain for the manufacture of a light anti-tank gun and mobile carriage.

As is now well known to the world at large, the collapse of France in June, 1940, aroused both Britain and this country to a thorough realization of the perils confronting civilization with the adoption of "blitz" warfare of massed and swiftly moving mechanical weapons. Canada was called upon to manufacture large quantities of guns, carriages, mountings, barrels, small arms and even the most complicated electrical fire-control equipment, to an extent hitherto thought impossible.

In order to lay the proper foundations for this vast programme, a large number of skilled engineers, designers, planners, etc sailed from Canada to study the methods of British gun manufacture in every important plant. The British Government provided these men with every facility for studying the latest designs and manufacturing methods and furnished them with all the requisite technical data which they cabled to their firms in Canada. To these men, some, alas, lost on the voyage to England, must be given a full measure of credit for their farsighted and skilful planning which has been the basis of the

success made by the manufacturers of Canada in turning a peacetime industry into a concentrated war effort.

Now let us review what really has been accomplished in this country in approximately the past 18 months. This period of 18 months is mentioned because it is safe to say, unfortunately, that nowhere in the democratic world did an intensified productive effort get under way before July, 1940.

From very small beginnings, plans were immediately laid, as a result of full co-operation between Great Britain and Canada, for the conversion of existing factories from peace to war needs and the erection of new plants thoroughly equipped with the most up-to-date machinery in the world. These new plants have been established from coast to coast, and it can truly be said that every province in the Dominion is contributing to the enormous programme now in full swing. The capital expenditure involved in the establishment of these plants amounts to approximately $150,000,000. This includes the cost of new buildings, conversion of existing buildings and the installation of the machinery and equipment.

There are over 30,000 people directly engaged in gun production, and it is more than likely that this figure will be increased to over 50,000 when production reaches its peak, as that peak is now seen.

As a result of the numerous expansions that have taken place during the past year, Ottawa has divided its direction of gun production into four sections, namely:

Guns, Army,
Guns, Navy,
Small Arms,
Electrical and Optical Instruments.

In order to get a proper appreciation of the magnitude of this new, to Canada, industry, it should be borne in mind that, with one exception, no one plant manufactures a completely finished equipment.

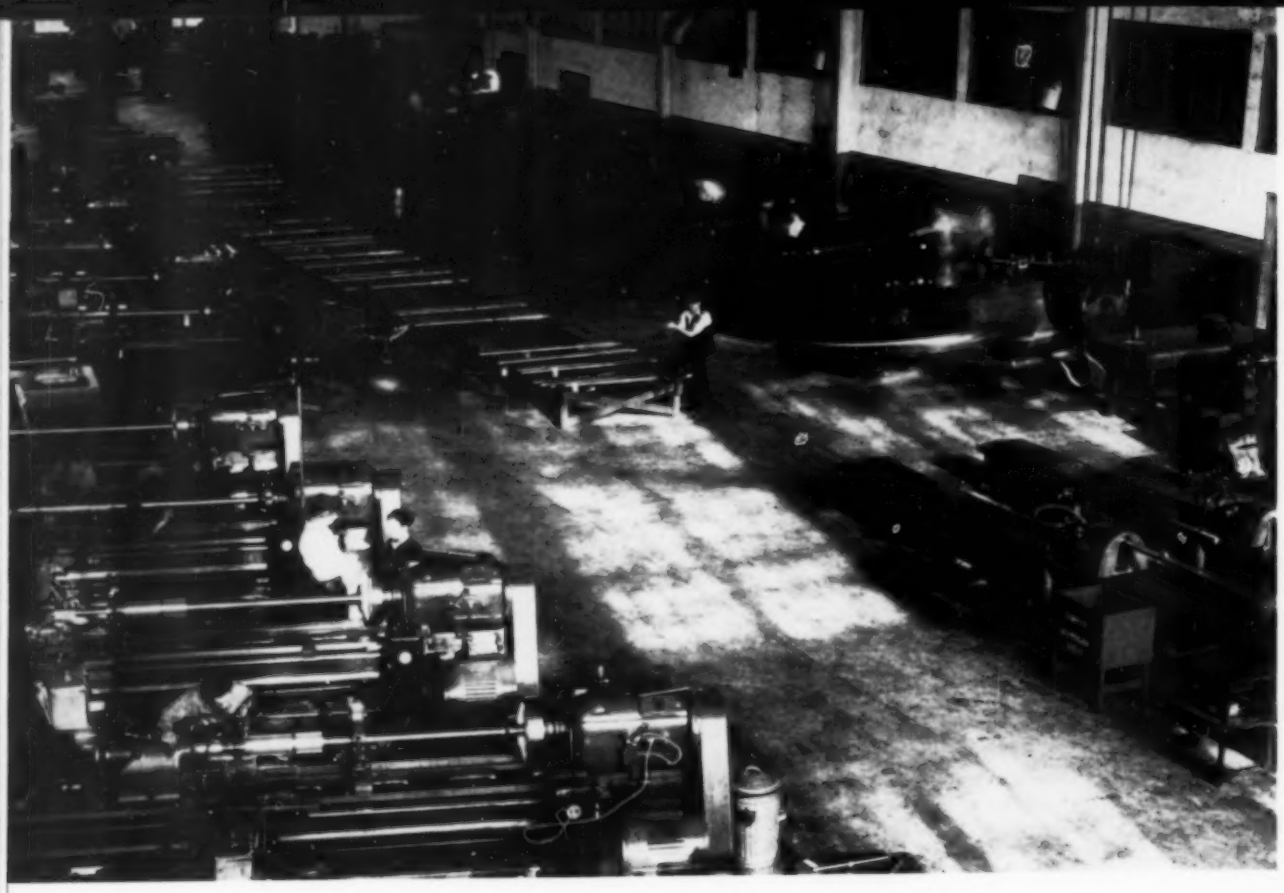
To illustrate this complexity, let me give you details of the wonderful 3.7" anti-aircraft gun now being produced.

1. The forgings for the gun barrels and jackets are made in a steel plant in Ontario.

2. The machining of the barrels is done at another plant, in the same province.

3. The forgings of the breech mechanisms are fabricated in plants extending

Construction of gun base for a Bofors gun



General view of a light anti-tank gun barrel shop

Inspecting line of anti-tank gun barrels. The craftsman at right is a veteran armament worker from Great Britain

Planing keys on gun barrel

Light anti-aircraft barrels

Above:—No mere formality was General A. G. L. McNaughton's visit to various tank and gun plants. Canada's Army Commander with characteristic intensity and attention to detail, examines a part of the breech mechanism of an anti-tank gun. With him are Major-General A. E. MacRae, military technical adviser to the Department of Munitions and Supply, and H. M. Black, plant manager.

Left:—Expert inspectors checking finished parts of breech mechanism against blue-prints of light anti-tank guns. This Canadian-built gun requires more than a thousand separate operations — the breech alone requiring forty-five.

from Nova Scotia to Ontario and sent to another Ontario plant for finish machining.

4. The mobile mounting, consisting itself of over 1,200 parts, is manufactured in a Canadian General Electric Company plant.

5. The amazingly intricate electrical firing control and optical equipment is manufactured at numerous points on the North American continent.

To illustrate further the work required in gun making let us give you a brief outline of the operation history of a 3.7" A.A. gun barrel.

When received by the gun plant the forging weighs about 3,000 pounds and then starts the multifarious processes necessary to turn out a finished barrel ready for service conditions. The barrel is machine turned and bored for auto-frettage (a hydraulic process of subjecting the barrel to internal pressure in order to leave the inner layers of the barrel in a state of compression). After the auto-frettage treatment, there follows a series of operations, low temperature treatment to restore elastic properties, outside finish machining, boring, rifling, chambering, etc., etc. Altogether there are 32 different operations to be performed requiring approximately two whole weeks of continuous work, 24 hours a day, six days a week. From its original forging weight of 3,000 pounds the finished barrel now weighs around 1,300 pounds, which provides an idea of the machining necessary to be done.

In spite of this amount of work the output of barrels at this plant now runs into double figures for every day of the week.

The breech ring, weighing about the same as the barrel, requires a mass of complicated machine work and takes no less than three months, 24 hours a day, six days a week, to produce the finished ring for assembly into the gun.

Naturally, these operations apply to all the other gun plants and, therefore, this plant is merely used to illustrate

Quantity production is now under way on the anti-tank gun. There are 500 parts in each of these weapons and their manufacture requires a high degree of skill.

operations obtaining elsewhere in ratio to the size of the gun or component parts.

In addition to the list of what are termed prime contractors there are literally hundreds of smaller organizations down to the smallest machine shop which are fully occupied in contributing their quota to the manufacture of this equipment by working under sub-contracts from the prime contractors, on numerous components, ranging from the largest to the smallest, dependent on capacity of production. This is the result of the now famous "bits and pieces programme" arranged by the Department of Munitions and Supply.

It is evident that before one completed unit can be produced, schedules of production and deliveries must be planned. All component parts must be delivered to prime contractors on given dates, and the delivery of the units being manufactured by each prime contractor must be so synchronized that all are delivered together to the plant where the complete gun is assembled and made ready for service.

When I referred to the expansions that had taken place during the past 18 months it is interesting to note that the scheduled output of this complete equipment has increased by no less than 600 per cent from its original programme. Some idea of the magnitude of this task may be seen when it is stated that each mounting for this equipment weighs no less than 7½ tons.

The cost of the completed equipment, which is a mobile unit mounted on rubber tired wheels and is therefore capable of being quickly transported from one locality to another, will be somewhere between $50,000 and $75,000 each.

As stated previously, this wonderful gun can throw a 25-pound shell a distance of seven miles in the air at a rate of 18 per minute, and no bomb-sighting apparatus has yet been devised that could make for anything but indiscriminate bombing at such a height.

The Bofors anti-aircraft gun is manufactured in Ontario in a plant built by the Government at a cost of nearly $10,000,000 and which ranks as one of the most modern and efficient plants of its kind in the world, covering an area of approximately 7½ acres, equipped with the most up-to-date machinery that it is possible to obtain.

There are some 2,300 employees engaged in this work, of which approximately 30 per cent are girls.

The very progressive management of this plant has shown that female labour can be trained for gun-making work as well as men. They are doing excellent work on automatic machines, in the tool and gauge shops and on inspection work; many are college graduates and all are very happy and enthusiastic in their work, which is carried on under the best conditions of cleanliness and ventilation.

The Bofors gun is also a complicated piece of mechanism consisting of approximately 1,800 separate parts and, like the large 3.7" A.A. gun, is mounted on heavy rubber tired wheels, thus being capable of rapid movement to any desired locality. An ingenious semi-automatic loading arrangement enables this gun to fire a 2-pound shell at a rate of no less than 130 per minute to a distance of 15,000 feet in the air. On account of this rapid rate of fire the Bofors constitutes one of the best known defences against low-flying and dive-bombing aeroplanes.

Through the enthusiastic and hard work of the management, combined with loyal co-operation of all sections of the staff, this plant has produced results that compare very favourably with any known similar organization in the world. The first complete equipment was produced in approximately 16 months from the time the company received the official go-ahead from Ottawa. It is easy to see what a creditable performance this is when consideration is given to the fact that a new large building had to be erected, completely equipped with machinery garnered from every quarter of this continent, huge stocks of raw materials acquired, a long range planning schedule of manufacture worked out well in advance and the acquisition and training of sufficient male and female workers to enable the company to turn out the large quantities of both complete Bofors equipments and the larger amount of loose barrels required.

It is most pleasing to record that the same results as described above have been achieved in numerous other gun plants throughout the country, and this plant has not been singled out for any other purpose than to give the reader a very brief idea of the enormous amount of executive skill and energy that has been so generously given by the various managements of these plants to Canada's war effort.

It would be nice to mention names; but if this were done the list would be so long that this article itself would be crowded out.

A few details of operations on Bofors

guns would be of interest. The rough forgings, undergo practically the same operations as previously described for its larger brother, the 3.7". On account of its smaller size the output is naturally much greater than the 3.7", and successive expansions of the barrel programme have resulted in the present authorized schedule showing exactly a 500 per cent increase from the original basis. To date many thousands of loose barrels have been produced, and these, with the naturally smaller quantity of 3.7" loose barrels have been shipped to various theatres of war, including the United Kingdom, United States, Libya, Egypt, India, Malaya, Iraq and China. The high standard of manufacture of both these barrels, together with the quantity shipped, has been a war contribution of great value. Loose barrels, as spares, are provided with all modern guns, and, when these barrels become heated due to rapid firing, an ingenious arrangement allows the barrel to be removed and a new one installed in a matter of a minute or two.

A production of Bofors guns of 2½ times the original figure will be reached this year; already several completed units are being delivered regularly every day of each week, and each successive month will see a greatly increased output.

All in all, the anti-aircraft gun production of Canada will constitute a quite impressive feature of Empire war measures.

Now let us take a look at other gun activities throughout the Dominion, spread from coast to coast. Mention has already been made of the large forgings for A.A. guns fabricated in Nova Scotia. Both single and twin mountings for the naval 4" gun are also being manufactured and assembled in this province.

At a Quebec plant, two types of trench mortars, the infantry indispensable equipment, are being completely manufactured.

A plant in Quebec was designed for the complete manufacture of 25-pound field gun and carriage.

The plant includes laboratory, powerhouse, steel foundry, forges and presses, heat treatment and rough finish sections, machine shop, tool room, erecting and assembly divisions, stores and plate shop.

All the services of the plant—oil,

Canadian-made Bofors anti-aircraft guns, hauled by Canadian-made tractors, located at a strategical point of Canada's defences. These fast-firing guns are capable of hurling 140 shells a minute.

Works and administration buildings of the Bofors A. A. gun plant in Eastern Canada. Covering an area of approximately was commenced in October, 1940, and the first manufacturing equipment was

electric, heating and compressed air—are supplied to the various units of the plant by tunnels over 2,200 feet in length.

There is a wide variety of machines, ranging from a 200-ton press for forging down to the smallest tool. There are over 700 special machines plus more than 7,000 jigs, tools and gauges for intricate work; ten vertical electric furnaces for tempering gun barrels, eight of which can handle barrels 28 feet long; several steam and air drop hammers from 6½ tons downward; 40 travelling cranes and, of course, other and varied items too numerous to mention. The staff numbers approximately 2,500 men, 300 men being trained in the apprentice school.

Financed privately before the outbreak of war, the Canadian Government has since contributed sufficient capital to acquire control of the operation and the total money now invested in the plant runs into eight figures.

The 25-pounder equipment replaces the old 18-pounder of the last war and is composed of some 1,300 individual parts, many of which are interchangeable. Here, as indeed as in all modern guns, is demanded the highest standard of engineering skill. It is a quick firing gun, mounted on rubber tired wheels and has a greatly increased angle of elevation compared to the 18-pounder and can be regarded as a general utility weapon being used both for ordinary field work and anti-tank uses.

Large numbers of 25-pounder equipments have already been shipped overseas as well as being delivered to Canadian troops in Canada and progress is such that scheduled rates of deliveries have been considerably exceeded and it is expected before summer has passed output will be stepped up still further.

In regular production in this same plant is a complete 4" naval gun, the largest yet made in Canada. The barrel of this gun is 15 feet long, and the gun and breech mechanism is again a highly complicated piece of

Interior view of Bofors

7½ acres on one level, they constitute the largest intermediate anti-aircraft gun plant in the British Empire. Construction installed in March 1941 — fourteen winter weeks from mud to machinery.

engineering. The mounting for this gun is made in Nova Scotia. It is unnecessary to emphasize its importance to the Empire's Navies.

A Quebec engineering plant was purchased by the Government and, like all the other main factories throughout the country, was equipped with the most modern machinery and equipment for its programme of the manufacture of both tank and anti-tank guns at a cost of some $10,000,000. This most progressive and aggressive plant is now turning out, in very impressive quantities, a light tank and light anti-tank gun and also heavy tank and anti-tank guns.

Conversion of the plant from its peacetime avocation to intensified war production was achieved in approximately 15 months. Within a remarkably short time from the beginning of regular production this plant was turning out complete guns at a rate nearly three times as great as had been scheduled. Far from contentedly resting on its oars at this fine performance it set out for fresh laurels with the result that by the end of this year it is confidently expected that regular production will attain a figure 750 per cent greater than was first arranged.

It is obvious that such results could only be achieved by a combination of the highest executive administration and loyal co-operation of all the staff, etc., etc. An instance of this is shown in the fact that before production began there were no designs for the 1,200 major fixtures and smaller items, including special tools and cutters, available to the firm. So, the very capable staff not only designed them but manufactured them as well.

The manufacture of this gun entails no less than 1,000 separate operations before assembly, the breech mechanism alone requiring 45.

Large quantities of these guns have been shipped overseas, the first consignment going forward in July, 1941. Reports

A. A. gun plant

from England give these guns an A.1 rating of excellence of manufacture. In addition to delivery to Canada and the United Kingdom, these guns, both tank and anti-tank, have been shipped to Russia, China, the United States and New Zealand; it is, quite possible that many consigned to the United Kingdom have been diverted to other areas also.

Yet another Quebec plant is producing what is possibly the most complicated gun mounting made in Canada, the naval quadruple anti-aircraft, better known as "pom-poms", which is now a familiar sight to all movie-goers.

Railway shops are making their contribution. At one the fabrication of the 4.5" gun carriage is proceeding, and production should commence in the near future. They are also producing here the 12-pounder naval gun, the general utility weapon mostly used by merchant vessels. While regular production has only commenced during the past three months, the weekly scheduled output has already been exceeded. The mounting, an intricate piece of mechanism, is so designed as to allow this gun to be elevated or depressed at angles sufficient to render it an effective weapon against either aircraft or surface vessels.

Canadian Car and Foundry Company, Limited is making recuperators for both tank and anti-tank guns and regular production is in full swing. Previously in this article it was mentioned that the fabrication of present-day recuperators demanded the highest of engineering skill. The recuperator starts its life as a large forging which is machined internally and externally to give the minimum weight for the particular gun for which it is being made. Included, also, is the boring of several long holes, all perfect in alignment, of mirror-like finish and with micrometer accuracy in diameters. The buffer mechanism is provided by a piston inside a cylinder operating against oil pressure, which combines with either compressed air or steel springs to bring the gun back into firing position.

One Ontario plant is busily engaged making trailers for the 25-pounder field gun. This sturdy waggon carries ammunition in specially designed ammunition trays, as well as various stores. Made of special steel, excepting the doors on the shell section which are made of heavy armour plate, the trailer weighs some 3,400 pounds, when loaded and about one ton unloaded. Seven hundred and fifty separate parts go into its manufacture. Many hundreds of these trailers have already been shipped to all theatres of war, and here again production is progressively rising. Much credit is due to the management here in converting an old plant to modern needs and training the necessary labour, mostly quite unskilled at the beginning, to a state of efficiency that now is responsible for a smooth production much greater than was thought possible at first.

Reference has been made to the 3.7" A.A. gun mounting made by Canadian General Electric Company, Limited. The amount of work involved in this can best be judged by a glimpse of the photograph, and it can safely be said that of all the difficult and complicated tasks set for Canadian manufacturers, this mounting, with its 1,200 separate and distinct parts, requiring in many instances watch-like precision, constitutes the acme of gun projects. It is therefore pleasing to record the commencement of production after a long period of initial planning and manufacture of parts, and, here also, the scheduled rate of production will be largely increased from the original rate.

At the moment, 1,600 employees is are employed solely on this project, of whom around 400 are student operators.

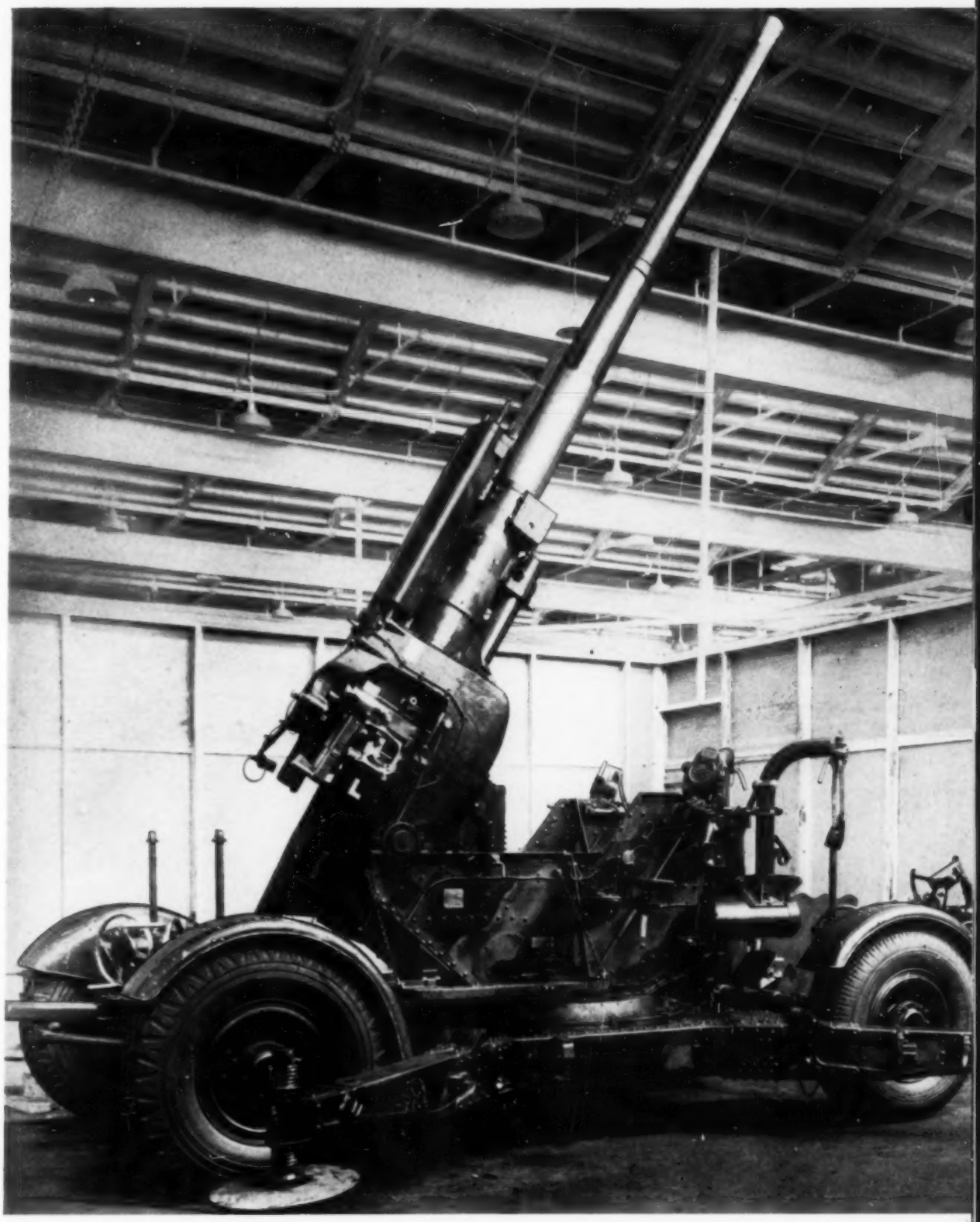
A locomotive company is making the single mounting for the "pom-pom" naval anti-aircraft guns and here, also, initial production schedules are being exceeded.

An elevator equipment company is turning out 2" trench mortars in considerable numbers.

In an Ontario plant, in addition to the well-known Bren gun, the Browning aircraft machine gun is also being produced in large quantities. Here, too, the production of anti-tank rifles has commenced.

The scheduled output of this plant, certainly the largest of its kind in the democratic world, employing 7,900 workers, of whom 42 per cent are women, is indeed a striking testimonial to Canadian energy and skill.

The Bren is as nearly fool-proof as is



The famous 3.7" A. A. gun

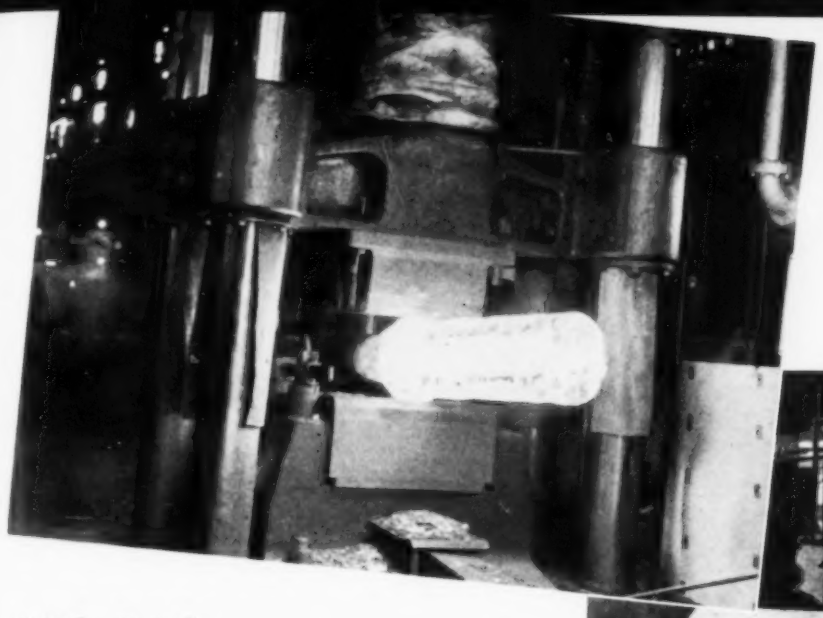
Right:—Yesterday, these chunks of scrap iron were automobile engines, steam pipes, washing machines and countless other forms of "junk" — to-morrow, they will be steel ingots and the day after, guns and tanks with which to smash the enemy.

TURNING SCRAP

Left:—Molten metal — from scrap iron — being poured into ingots.

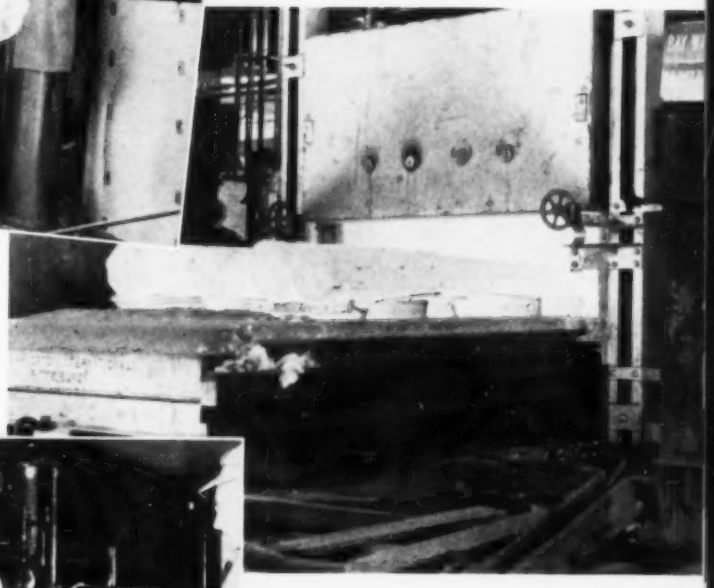
Right:—Twenty-four hours a day, seven days a week, the great electric furnaces in this Canadian arms plant provide a steady flow of molten metal for use in the manufacture of heavy guns. This particular furnace developing 3,000° Fahrenheit reduces ten tons of metal to liquid steel in three hours.

Below:—Tapping molten steel from the ladle into ingot forms provides a pyrotechnical display.

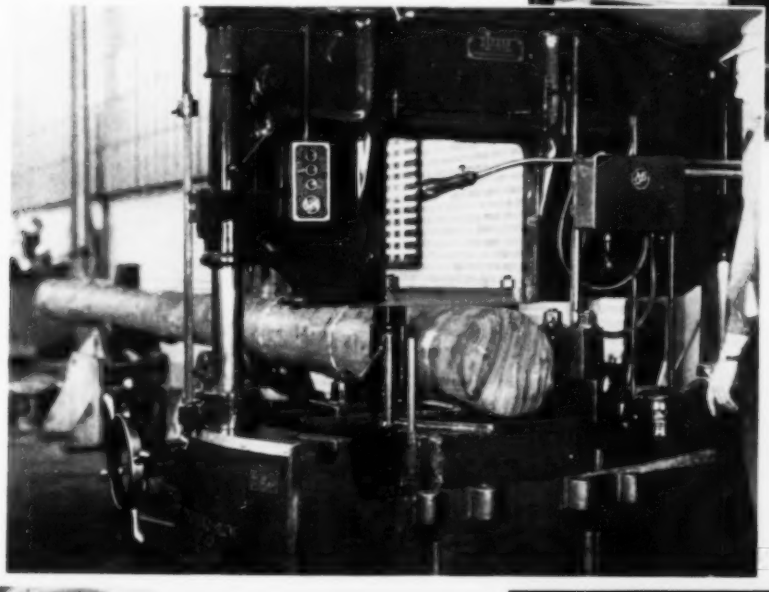


Left:—A partially forged gun ingot being pressed under a 1,000-ton steam hydraulic press — the first operation in the processing of a gun.

INTO GUNS



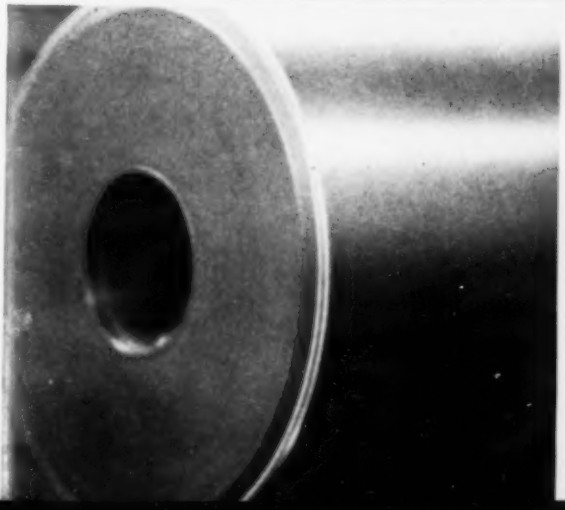
Right:—Four completed gun forgings are being withdrawn from a gas heated annealing furnace after being held at a predetermined temperature to refine the grain.

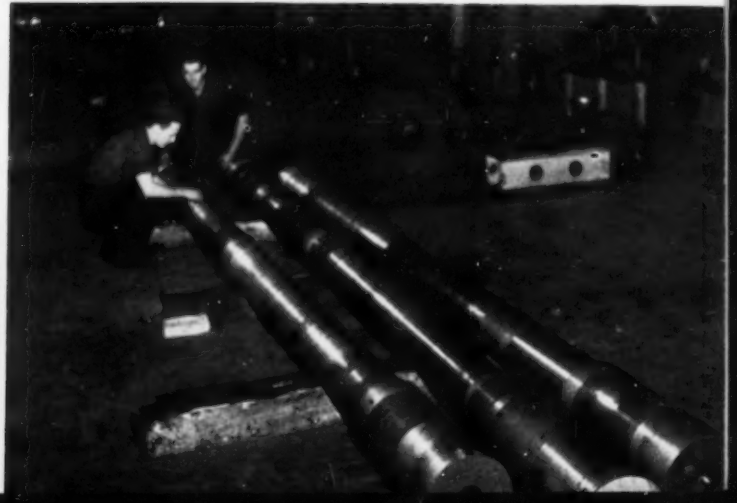


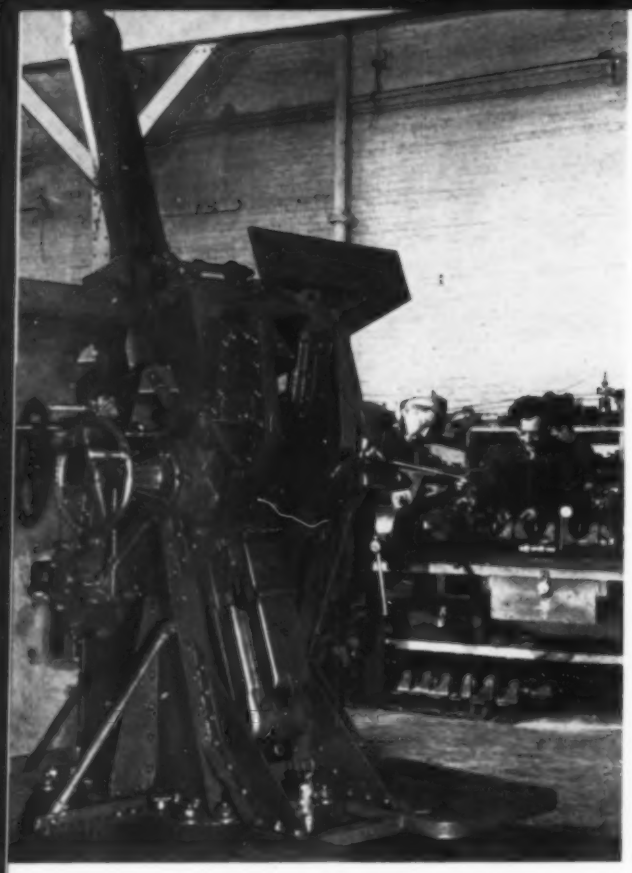
Left:—The end of the long gun barrels are sawn off when in the rough forged state.

Below:—Finished 3.7" anti-aircraft gun barrels are checked for accuracy in a Canadian steel plant.

Centre bottom:—With the gun barrel completed, the cutter used to bore the 3" hole is withdrawn.







Manufacture of "pom-pom" gun mounting

possible. Parts cannot be assembled incorrectly. There is only one way that the various parts fit one into the other and that must be the correct way. Each gun is equipped with a spare barrel and 24 magazines, each holding 30 cartridges; one magazine can be replaced by another in a few seconds. The body of a Bren gun consists of a rough forging weighing 45 pounds; this forging passes through 269 separate operations before completion. Many of these operations require more than one handling and must be gauged after each operation, and so it follows that hundreds of people have had a hand in the production of the gun. The original 45-pound forging emerges a finished gun body weighing only 5½ pounds. No less than 18 different kinds of steel are used in the manufacture of each Bren gun.

The Bren can fire about 550 rounds per minute, but this rate of fire is reduced to around 150 a minute under active service conditions. Many thousands of these weapons have been shipped to all theatres of war.

The newest sub-machine gun

Trench mortars

The Browning machine guns produced here are housed in the wings of Spitfires and Hurricanes, six or eight in each plane. They are capable of a burst of fire at a rate exceeding 1,000 per minute and can cut an enemy plane to pieces. While not as intricate as the Bren, 2,500 separate operations are required in its manufacture.

So perfect has become the system of mass production of small arms that it has been acknowledged by visiting ordnance experts, British and American alike, to be not only the largest but one of the most efficient plants of its kind in the world. Expansions should not be mentioned as output has increased so much and so often from original schedules that even Ottawa finds it difficult to keep pace with them.

A wholly Government-owned plant in Ontario is making the most modern rifle at a rate of thousands per month and the

The Lee-Enfield rifle and bayonet held at the attack position by this soldier is turned out by a Government company. The bayonet is the new type adopted by the Canadian Army. Much shorter, triangular in shape, it is slimmer than the 1941 version, easier to handle and every bit as efficient.

This intricate display gives some idea of the precision requirements and variety of finely-machined parts which go into the manufacture of mounts for 12-pound naval guns.

Tooled to precision these parts represent a few of the 1,287 which go into the production of a field gun.

latest sub-machine gun, beloved of Commandos.

A western steel products plant is turning out ammunition trays for the 25-pounder trailer.

Another plant in the West has shipped its first hundred 25-pounder trailers.

A western subsidiary of General Motors of Canada, Limited, is producing anti-tank gun carriages. In a matter of a few months shipments overseas have already been made. It has the distinction of being the only company in Canada using the belt conveyor system of assembly, and this country will reap the benefit of their long experience of automobile mass production methods.

What is now a naval ordnance plant in Western Canada was converted from peace-time industry at a cost of $3,000,000 and employs over 1,500 men.

Here is made the 12-pounder naval gun and mounting complete, including loading and firing mechanism.

Yet another plant in the West is rapidly approaching production of the naval anti-aircraft "pom-pom" gun.

In addition to the long list above mentioned, literally hundreds of other plants are working day and night on sub-contracting orders; these are spread, just as are the prime contractors, from coast to coast. Not all these sub-contractors are the little fellows; indeed they range from huge organizations like National Steel Car all the way down the line to the smallest machine tool shop in the country. With the promised restriction of civilian commodities it is safe to say that in the near future no industrial establishment will exist that will not in some measure be contributing to this country's war effort.

A special paragraph is reserved for the Government-owned Research Enterprises, Limited near Toronto. This plant is devoted to the supply of Army and Navy optical and non-optical instruments and fire-control equipment. It was mentioned earlier in this article that modern gunnery has made necessary the use of extremely intricate and delicate remote fire-control equipment both for Army and Navy. All these were entirely unknown to Canadian manufacturers. Some of the more complicated units consist of 5,000 parts, the fabrication of which involves many months of planning and the use of special machines and tools.

Research Enterprises, Limited are playing a leading part in the production of these fine instruments generally, and more especially optical instruments of all types and special radio equipment.

Aside from this Government plant there are more than 40 prime contractors working on instruments and fire-control equipment and related components, assisted by a host of sub-contractors. Generous assistance has also been provided from the facilities and expert technical assistance of the National Research Council and the Department of Transport's Meteorological Office in Toronto.

The list of components produced, including optical glass of the finest quality, comprises telescopes, height and range-finders, clinometers, compasses, etc. and numerous other secret contrivances which, for very obvious reasons, cannot be mentioned here.

It can be stated that Research Enterprises, Limited together with both the prime contractors and sub-contractors spread from coast to coast are making a most important contribution to the whole gun programme.

In conclusion, it would ill become anyone writing such an article as this not to record the debt the country owes to some of the people, apart from manufacturers, who are directing this huge programme.

Heading the list is the Minister of Munitions and Supply, the Honourable C. D. Howe, who, in spite of his multifarious duties, has had the direction of the whole munitions programme from its inception. He has kept and does keep a very watchful and parental eye on the whole proceeding in all its ramifications, complications and perplexities.

The responsibility for actual production fell originally on the shoulders of Mr. E. P. Taylor of Toronto, acting directly under the Minister and who, aided by equally able and enthusiastic associates, laid the foundation of the present large scale operations of gun production in Canada.

Above: — Mountings for Vickers naval machine guns are being made in an Ontario plant — originally designed as a shoe factory.

Left: — Not the ribs of some huge monster, but cap-squares for Vickers naval twin mountings. The cradle which holds the two machine guns revolves in a set of these bearings.

Workmen in a Canadian armament plant put the finishing touches on a 12-pounder naval gun.

In the early part of 1941, Mr. Taylor was appointed to Washington, and in August of that year Prime Minister Winston Churchill nominated him as President of the British Supply Council of North America.

Following Mr. Taylor's departure from Ottawa, Mr. Harry J. Carmichael was appointed Director General of all sections of gun production throughout Canada.

At great financial sacrifice, Mr. Carmichael resigned his position of Vice-President and General Manager of General Motors of Canada, Limited to come to Ottawa and work 14 hours a day and pay his own expenses, even when travelling on Government business.

As one of the oft-maligned "dollar-a-year" men, he is absolutely untiring in his efforts for production and still more production. "Harry", as he is known to industry in Canada, is also President of War Supplies, Limited, a Government company formed to implement the "Hyde Park" agreement between the United States and Canada. He is also Chairman of the Production and Allocation Committees, which, amongst other things, decide the disposition of all equipment to the localities in most need of these.

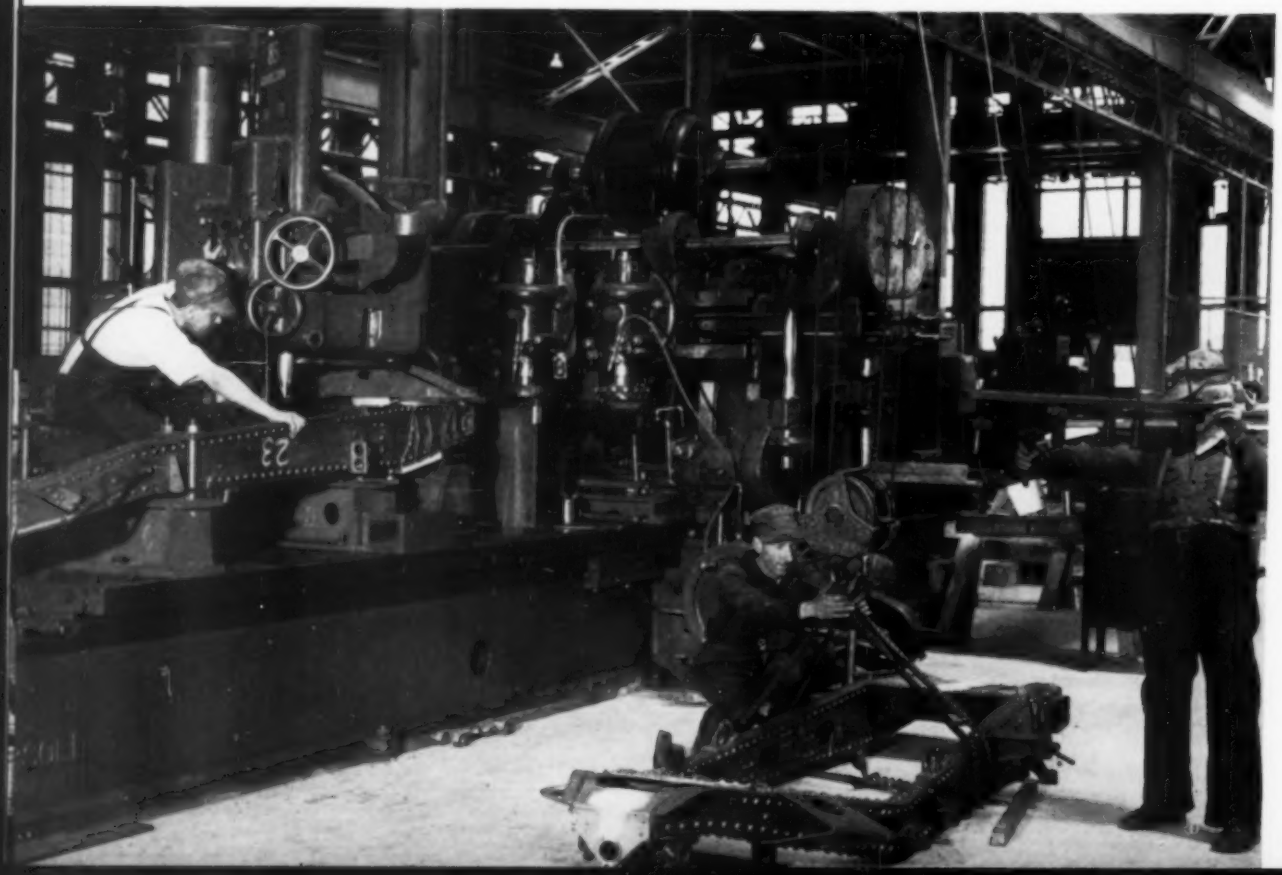
Mention must also be made of the great services rendered by the British Admiralty and the British Military Technical Missions, headed respectively by Vice-Admiral A. E. Evans, C.B., O.B.E. and Major-General A. E. Macrae, O.B.E., also the Inspection Board of the United Kingdom and Canada, under the direction of Major-General R. F. Lock, C.B.

The technical assistance given all Canadian manufacturers by these gentlemen and their able staffs has been of great benefit to our new gun industry.

In the writer's opinion the foregoing recital constitutes an effective answer to the parrot-like question that is sometimes voiced as to "What is Canada doing?" and it is considered that the gun programme and the results already achieved make a truly impressive record for a young country starting from scratch and one of which any Canadian can justly feel well proud.

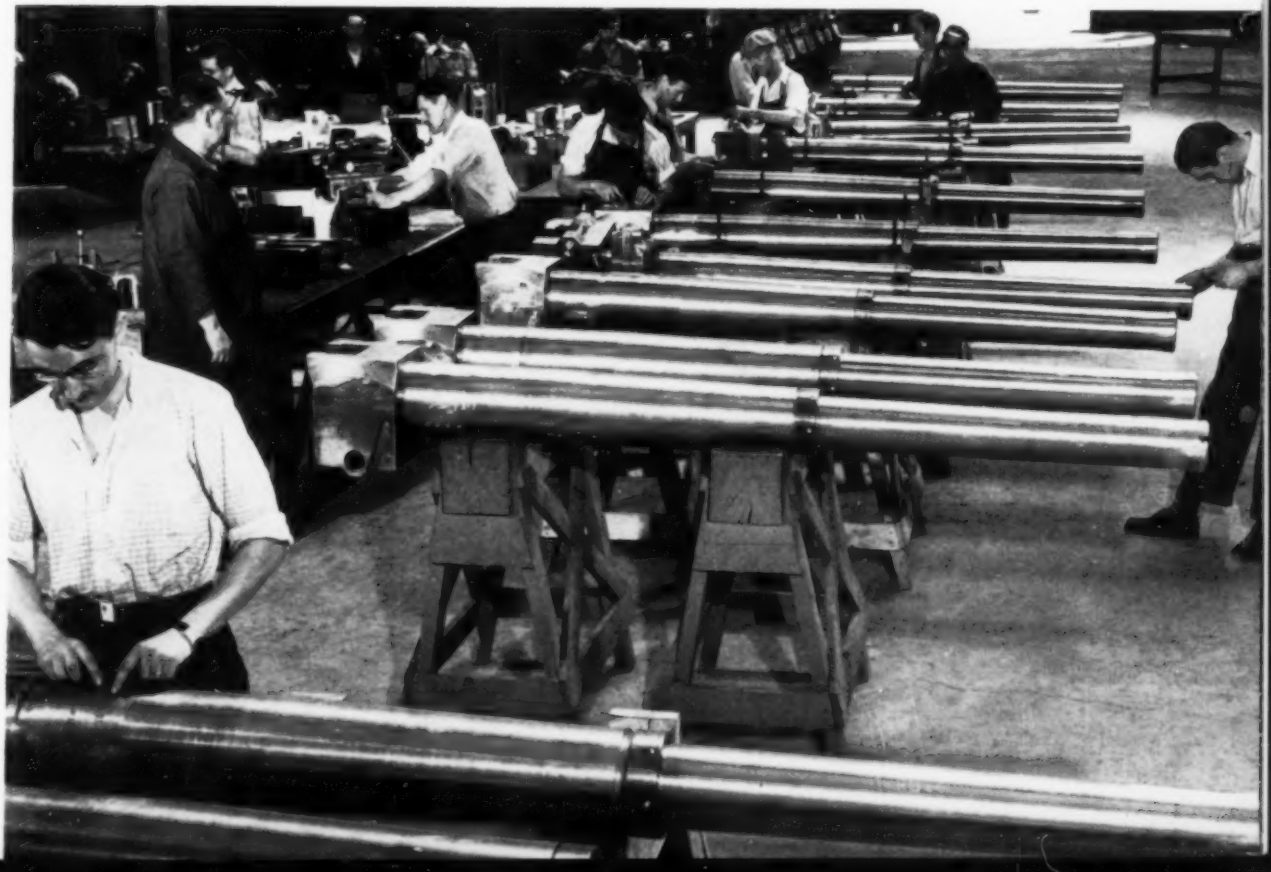
Plant officials and workers checking details of construction of a 25-pounder gun on blue-prints of specification. Two field pieces-just about ready for action may be seen in foregound.

This giant multiple milling machine makes eight cuts on the under-carriage of the 25-pounder field gun in one operation.



Colonel the Hon. J. L. Ralston, Minister of National Defence, accompanied by a group of military and civil authorities inspect a 25-pounder gun.

Here 25-pounder gun barrels are equipped with the breech mechanism.

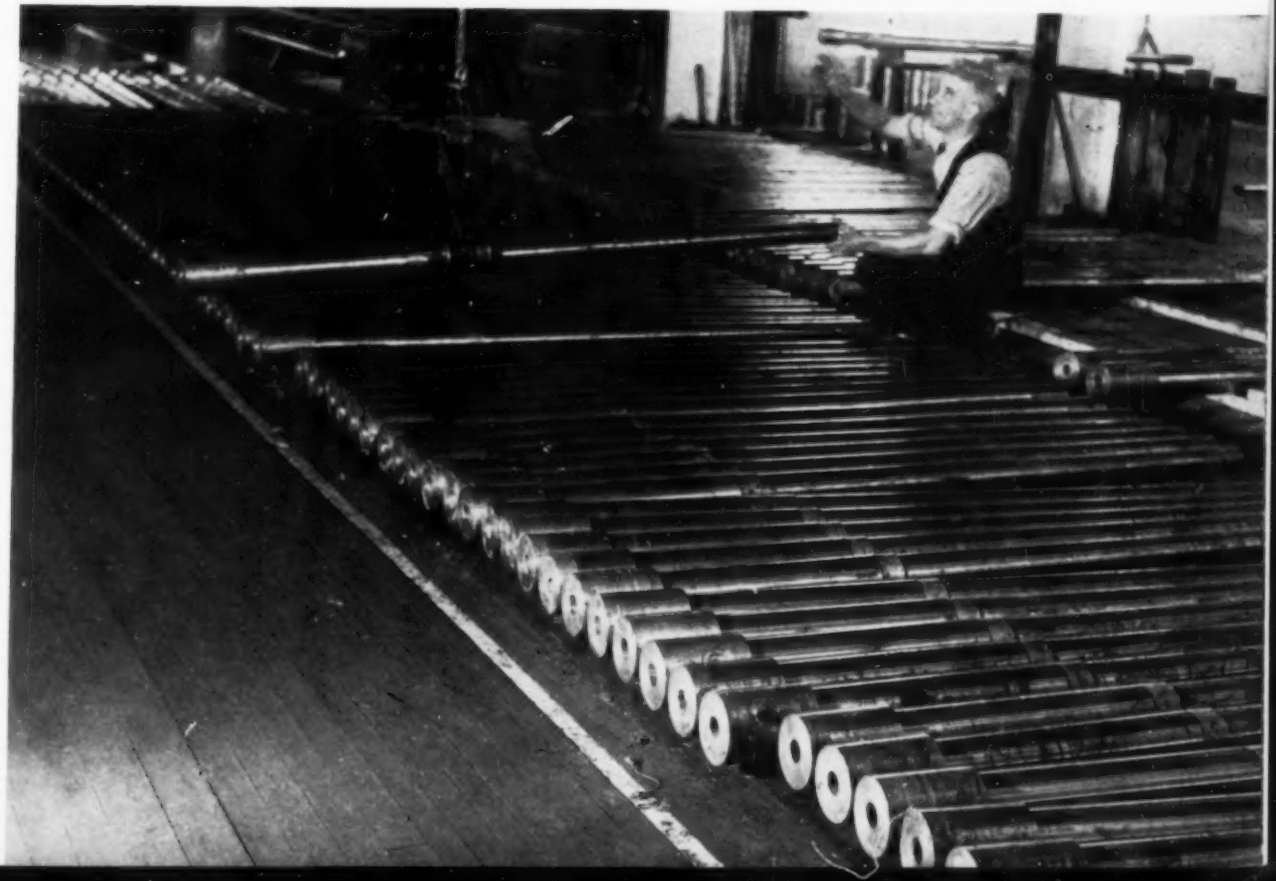


25-pounder gun in operation at Petawawa

25-pounder field gun with trailer

3.7 gun barrels receive their final inspection.

Canadian-made Bofors anti-aircraft guns share in keeping the skies over Britain clear of Nazi planes. These rapid-fire weapons require the best in material and workmanship. Barrels lined up in a Canadian plant.

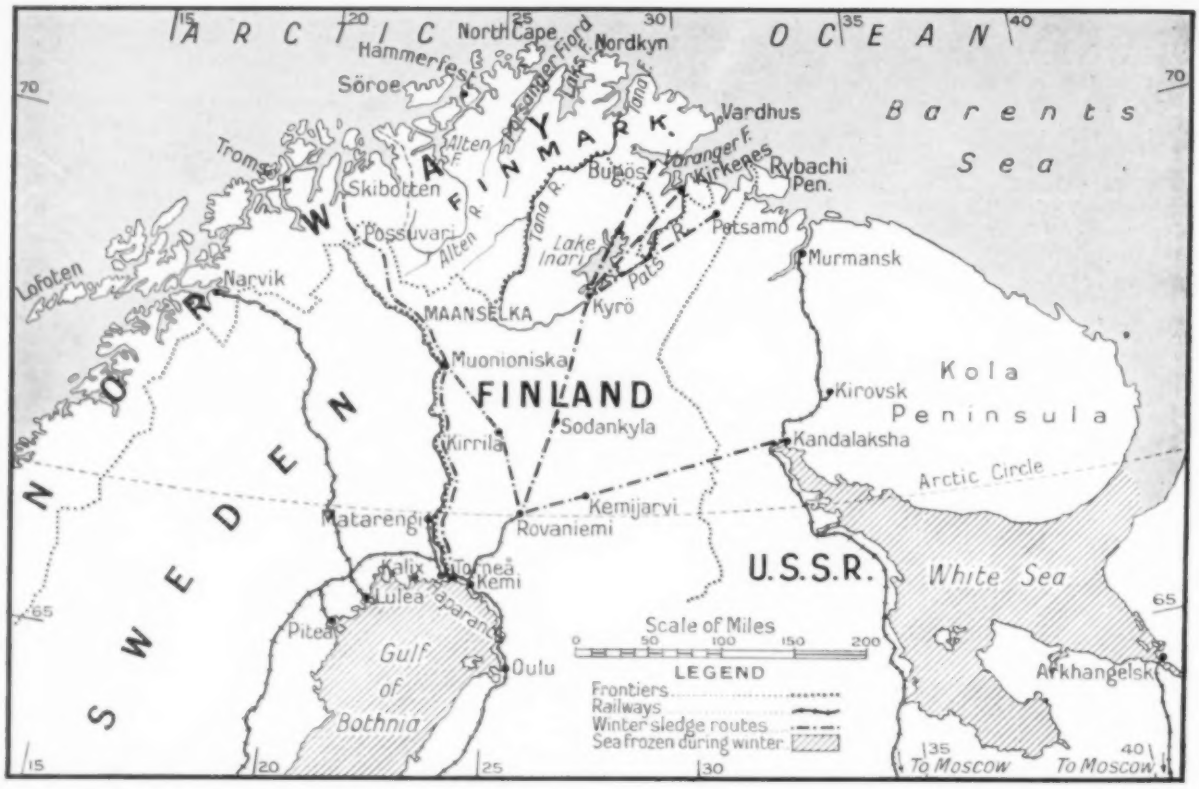


Visit of the Chinese Delegation led by Dr. T. V. Soong, Foreign Minister of China to Bren gun plant. Immediately behind Dr. Soong, is Harry J. Carmichael, Director General of the Gun Production Branch of the Department of Munitions and Supp'y.

Lieutenant-General A. G. L. McNaughton, Canadian Army Commander and Major-General A. E. MacRae, British Military Technical Mission, visit the Bren gun plant.

General view of one section of a Bren machine gun plant in Canada

Soldiers of the Canadian Army testing a finished Bren gun.



C.G.J. MAP

Fig. 1. *The Extent and Location of Finmark.* Both latitudinal situation and geomorphology limit rigidly the potentialities of Finmark as a base for economic enterprise. Notice Arctic trade routes, converging upon Finmark which were used by Russia during the Four Years' War, their concentration upon Varanger Fiord and the absence of rail communications in Scandinavian Lapland.

FINMARK

AN HISTORICO-GEOGRAPHICAL STUDY

by **W. R. MEAD**

FINNMARK, the largest and northernmost province of the kingdom of Norway is located within the Arctic confines of the European continent. Structurally, it is a wild Alpine terrain, with five great laterally branched fiords piercing into its mountainous core of crystalline rock. The rugged cliffs of its northern littoral command Barent's Sea — the fingered promontaries and islands pointing the way to Spitzbergen and the polar ice cap. The province, or "Fylker", falls into two principal physical regions (see Fig. 1). Although there is no natural boundary, a line drawn from the inner reaches of Varanger Fiord to the southern extremity of Alta Fiord traces the division. Since early times, this distinction has been recognized. Dr. John Scheffer, writing in 1673, stated: "One part thereof, lying along the coasts of the ocean, is from thence called Sioefindmarken, that is maritime Lapland: the other, lying higher on the continent, Fiælmarken, that is inner Lapland"(i).

This barren fell country of the hinterland, rising to the borderlands of the axial mountain range between Norway and Finland, is almost as lifeless as the coastal zone is vital. Climatically, Finmark enjoys a unique regime for its northerly location, experiencing the beneficient influence of a warm ocean current. The littoral region, for example, where relatively warm surface waters penetrate into the fiords has isoanomalies of +20°C and +4°C in January and July respectively. Relative humidity is high, but precipitation low. Toward the interior, where altitude counteracts the modifying maritime influence, continental factors rapidly assert themselves. Within the province of Finmark, which approximates in size to Switzerland, lives a population of some 60,000—giving an average

(i) "The History of Lapland". Oxford. 1674. p. 9. This geographical division seems to have been first noted in J. Blaue's "Geographie". Vol. II, p. 27. Amsterdam. 1663.

density of 2.87 per square mile. Coastal settlements are populated chiefly by Norwegians, while the hinterland is peopled sparsely by semi-nomadic Lapps.

In the historical geography of Finmark, we can distinguish two principal forces in operation. On the one hand, there is the coastal force or maritime peoples—Norwegians and Danes holding tenaciously the Arctic littoral which they have occupied since at least the thirteenth century. On the other hand, we can discern the force of continental peoples—Russia and Baltic Sweden—pushing toward the ice-free waters of the North Atlantic Ocean. Human settlement in Finmark is surprisingly old and relics of its prehistoric culture have been the subject of extensive research (ii).

In the earliest written records, which date from the Middle Ages, when there began to emerge a distinct national consciousness among Scandinavian coastal peoples, there is specific reference to the innate antipathy between the littoral and continental elements. Thus, century old friction was the preliminary to the 1264 agreement between King Haakon Haakonson and the Grand Duke of Novgorod (iii). This, in turn, was precursor to a succession of fourteenth and fifteenth century contracts between Denmark-Norway and Moscovy. Periods of peaceful trading, e.g. commercial treaty of 1326, were interrupted by Russian plunderings of the coastal inhabitants of Finmark. Finmark, in these times, was a vastly different conception from the present-day entity enclosed within its stable territorial confines. It was a name given to an undefined area which stretched from Lofoten to the throat of the White Sea. Over this vast expanse Danish and Norwegian monarchs claimed sovereignty. It seems clear that in the undocumented times before the thirteenth century, the coastal peoples dominated Kola—for, although Moscovy claimed the peninsula and the intervening sea, it acknowledged unwittingly Norwegian ownership by calling the former Mourmansk and the latter Mourmansk More (corrupted forms of Norman Sea and Norman Land). Russian penetration was slow, but effective. The confines of Arctic Denmark, having recoiled steadily before it, were crystallizing by the sixteenth century.

At this date, the rise of an independent and expansionist Sweden introduced a new factor into the Finmark question. Access to the Atlantic Ocean was barred for Sweden by the Danish Empire, which occupied the entire West Coast. Swedish imperialism was confined, therefore, principally to the Baltic arena. However, with its growing might, it drove a spearhead of attack through the Gota valley to the shores of the North Sea, and, by penetrating into Lapland, sought annexation of an Arctic palatinate.

There were, of course, economic forces which aroused interest in territorial possession of this geographically remote area. In the first place, ownership of Finmark implied the right of "Skot" over the indigenous peoples (particularly the Lapps whose valuable reindeer herds and trapping activity offered grounds for extraction of taxes). The seasonal migration of Laplanders, coupled with the undefined contours of Danish, Swedish and Russian "Skot-lands", resulted in a three-fold oppression of the unfortunate natives. Thus, in the journal of Stephen Burrough, written in 1557, we read:—"The Lappians pay tribute simultaneously to the Emperor of Russia, to the King of Denmark and to the King of Sweden" (iv). Secondly, the value of the rich coastal fisheries was given new interpretation by the maritime discoveries of the sixteenth century which widened geographical perspectives and stimulated long distance trading. In particular, the discovery (or rediscovery — c.f. the journey of Orosius into the Arctic Ocean in King Alfred's time) of the North-east Arctic passage to Moscovy in 1553 stimulated interest in the natural resources of Finmark.

Of greater significance than this, however, was the fact that Finmark was endowed with a new strategical and economic importance for Denmark. Barent's Sea, navigated by Norsemen since the Bronze Age, was opened to seafaring Dutch and British, and this route to the White Sea ports offered an alternative to the Baltic Sea route, which was controlled by Denmark at the Oresund. The Sound

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(ii) e.g. Johs. Boe et A. Nummdal. "Le Finmarkien". Instituttet for Sammenlignende Kulturforskning. Oslo. 1936.

(iii) "Norges Land og Folk". "Topografisk-Statistisk Beskrivelse over Finmarkens Amt." A Helland. Kristiana. 1905. Vol. I, p. 66.

(iv) Richard Hakluyt's "Voyages". Everyman Edition. Vol. I, p. 376.

Dues were a source of royal revenue and the prospect of White Sea trade with Russia was calculated to reduce their total. Christian IV of Denmark and Norway, acknowledged ruler of Iceland and Spitzbergen, claimed the right to levy taxes on ships doubling the North Cape, because of his possession of contiguous shore-lines (v). Although the sum of a thousand Danish marks was extracted from English merchant adventurers for the right to use the North Cape route, this arrangement met with no more success than the same monarch's attempt to concentrate the monopoly of Finmark's trade in Bergen. In point of fact, the Baltic route to Russia remained the principal channel of trade, for although the Sound Dues made it a little more costly, it was far less dangerous (vi). The vigorous Finmark policy of Christian IV had one very positive result—it succeeded in establishing firmly Norwegian sovereignty over maritime Finmark, with its excellent harbours and wealthy fisheries. The accompanying maps give an idea of the framework of Finmark in Renaissance times.

The human geography of Finmark in the sixteenth and seventeenth centuries differed little in its essentials from that of the present day. Distribution of population was determined by the same natural agencies, and exploitation of natural resources followed the same extractive process. It has been estimated that a mixed population of about 4,000 persons, scattered among some thirty to forty settlements, inhabited the territory — exclusive of migrating Lapps (vii). The greater part of these inhabitants were Norsemen; although a large proportion of Finns were attracted from the interior. A sprinkling of Scottish, English, Dutch and German names in sixteenth century records indicates intermixture of races along the thalassic rim (viii). Coastal population seems to have fluctuated, shifting its place of residence according to surfeit or deficiency of fish. Among permanent settlements, Vardhus appears to have been of greatest significance — rather as a consequence of its strategic importance than of any inherent advantages in the economic field. The fortress of Vardhus, founded about 1307, is located at the entrance to Varanger Fiord upon the great quadrilateral of the Varanger peninsula. It was the outpost of the Norwegian Empire and port of call for most vessels bound for the White Sea. It has been maintained that unless Norway had established the fortress of Vardhus in the fourteenth century, Finmark would have become Russian territory. Sir Hugh Willoughby anchored at Vardhus on his north-eastern voyage and termed it "the strongest holde in Finmarke". "The King of Denmark doth fortify it with men of warre; and the Russes may not goe to the Westward of the castle", we read in another part of Hakluyt's miscellany. Yet, although a stronghold intended to keep in abeyance Russian encroachment, Vardhus was unable to resist the passive penetration of certain elements. Thus, fairs which were held two or three times annually throughout Finmark (see Fig. V) attracted a cosmopolitan attendance among which Russians were the dominant element. Thus, the foundation of a Russian monastery at Petchenga — "a Monastery of Monks of the Russes Religion", as Stephen Burrough called it — showed infiltration of the orthodox creed from its historical sphere of influence in the continental heartland.

For a description of the fishing industry, we cannot do better than turn to Olaus Magnus. In his illuminating sixteenth century treatise on Scandinavia, he wrote:— "Many thousands of Fishermen dwell in the villages in the utmost borders of Norway . . . and in other lands that lie about at Vardhus . . . In February and March and also in January, the inhabitants of this country go in strong ships to fish from the Shore into the Deep; as far as they can sail in two days, carrying with them the necessaries for their food for

(v) This opinion was immediately challenged by the merchants who, quoting the opinion of Grotius, held that a prince might not claim ownership of a strait of water, even though he owned the neighbouring shore-lines.

(vi) See T. J. Arne. "En Svensk Handelsspion i Ryssland pa 1600-Talet". Nordisk Tidsskrift, 1917.

(vii) A. Helland op. cit. Vol. III, p. 31.

(viii) From an anonymous item "Om Findmarcken". Historisk-Topografiske Skrifter om Norge og Norske Landsdele i 16de. Aarhundrede. Gustav Storm. Christiana. 1895. p. 225. See also "Finmarkens Beskrivelse af Erkebiskop Erik Walkendorf". Gustav Storm. Norske Geografiske Selskabs Aarsbok, 1901. p. 1-23.

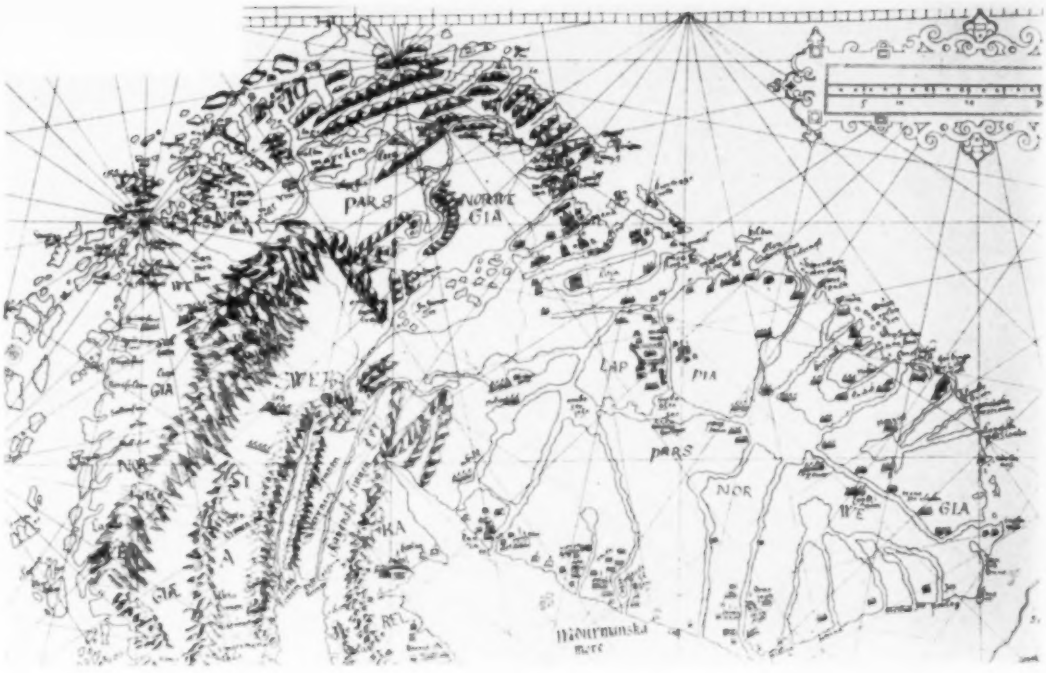

Fig. II. *Simon Van Salingen's Map of the Nothernmost Parts of Europe* (1601). Simon Van Salingen was a Dutch cartographer in the employ of the Danish crown; his map is in the Riksarkivet, Stockholm. It was published shortly after King Christian VI's personal expedition to the Russian borders of Finmark in 1599. The map betrays the author to be a mariner. Notice that the Kola peninsula, marked Lappia Pars Norwegia is claimed as a Norwegian possession and that the White Sea is designated "Mourmanska More".

twenty or thirty days" (ix). He told also of the salting and sale of the catches. The inhabitants "salt them whole with pickle and lay them in the Sun, and most sharp Winds, to dry by the cold piercing Ayr: then they pile them up like great Piles of Wood and put them again into Ships and carry them forth to the most famous Marr-Town of all Norway, called Bergen" (x). With the passage of time and decline of Bergen's monopoly, English and Dutch intermediaries undertook distribution of fish throughout the European market. In exchange for exports, Finmark imported foodstuffs ". . . Wollen and Linen cloth, Copper, Alchimy, Salt, Corn, Bulls' Hides, Sulphur, Needles and Pins, Knives, Spirit of Wine and Tobacco" (xi). Barter exchange was customary among the Lapps and common among the coastal inhabitants, who came to conduct their business in a kind of Lingua Franca called "Russenorske" — a patois which contained in addition a distinct English influence.

It was in the eighteenth century that the Scandinavian world first came under the shadow of Russian power and the retreat of the Swedish Empire before a nation seeking access to the sea was the prelude to a new and active phase of Russian expansion to the World Ocean. Territorial aggrandizement was not so much the aim as the corollary of a policy which sought maritime contacts. Pressure from the East was concentrated upon southern Finland, but Arctic Scandinavia also experienced repercussions of a contest between coastal and continental antagonists. Russian infiltration into Finmark, for instance, reached unduly large proportions in the 'nineties, when permanent settlement as contrasted with seasonal migration produced friction with native fishermen (xii). Of the sustained Danish interest in Finmark throughout the eighteenth century we have evidence in the papers edited by Pontoppidan (author of

(ix) "A Compendious History of the Goths, Swedes, Vandals and other Northern Nations". London, 1658. p. 223.

(x) Ibid. p. 224.

(xi) J. Scheffer, op. cit. p. 76.

(xii) O. A. Johnsen. "Finmarkens Politiske Historie". Videnskapsselskapets Skrifter II. Hist.-Philo. Klasse. 1922. No. 3. Kristiana. 1932. p. 221-225.

the exhaustive Dansk Atlas). From them, we may glean that eighteenth century trade of Finmark was concentrated upon Copenhagen. From this metropolis — over a thousand miles to the south — was drawn a manifold variety of commodities. Provisions, corn and flour, to the extent of more than 3,000 tons per annum, were exported from Copenhagen to the fiord settlements of Finmark. In 1785, which may be taken as an average year, total value of cargoes sent to this northern colony, approached 50,000 Rdlr. (£5,000). Copenhagen, jealous of this tolerably valuable trade opposed the competition of Russian merchants, who, besides bringing flour and meal from Archangel, engaged in smuggling. Among commodities declared by Denmark to be contraband in Russian bottoms were brandies and tobacco, French and Spanish salt. The hold retained over the salt trade by Denmark recalls the former monopoly held over this commodity by Lubeck merchants. We can appreciate the value of Finmark's fisheries from the fact that in the latter part of the eighteenth century, dried fish were exported from Arctic Norway to no less than thirty leading cities in Catholic Europe. The Danish crown was naturally concerned with the revenues from this lucrative industry.

We must now turn our attention to the nineteenth century and consider the position of Finmark in the post-Napoleonic map of Europe. Scandinavia experienced a metamorphosis. Denmark was reduced to lowly estate when Norway was united to Sweden with intent to create a powerful peninsular kingdom interposed between the rising might of Russian Empire and the Atlantic Coast. Russia, retaining the whole of the Grand Duchy of Finland, which had been annexed by successive stages down to 1809, was brought virtually to the threshold of the World Ocean. Thus, we can perceive the tendency of medieval times accepted as a guiding line of policy and translated into action with the weakening of the powers occupying the Scandinavian foreland.

Focusing our eyes upon Finmark, we find that one of the first results of Russian annexation of Finland was the establishment of a fixed land boundary with the Scandinavian countries. In 1825, after a meeting of the boundary commission in Kola, a permanent frontier was drawn up which made Finmark a virtual enclave within Russian (Finnish) territory. This territorial separation of Finmark from the peninsula kingdom of Norway-Sweden in conjunction with a vulnerable location vis-à-vis Russia, gave to nineteenth century Britain an interest in the fate of the Arctic province. It was not surprising that Finmark entered into the geographical arena of Palmerstonian politics. Attention was first called to Finmark's strategical relationship to Great Britain in the 'thirties, when Vice Consul Crow reported from Hammerfest of a rapidly developing Russian hegemony in the province (xiii). In the close economic ties which were binding Finmark to Russia, e.g. some 500 vessels were engaged in the Finmark trade, Crow saw the germs of political expansion. Pretext for the latter action was also given by territorial complications resulting from seasonal interstate migration of Lapps. Unimpeded movement of these nomad peoples over political boundaries had always reduced the real meaning of Arctic frontiers. Crow's thesis that Russian designs on the North Atlantic Coast would involve an initial occupation of Finmark, was a theme which impressed both Great Britain and Norway. The Consul thus wrote to Palmerston that Finmark was destined to suffer the fate of Finland, and, in fuller despatches, stressed its natural advantages for a prospective maritime power — the great extent of coastline, excellence of the harbours, with ports "capable of containing all the navies in the world; . . . and a sufficient number of sailors to man the largest fleets" nursed in the offshore fisheries (xiv). The strategical position of Finmark, always realized by Norway-Denmark, was now appreciated by Britain, and the determination of the latter to exclude the continental force of Russia from a commanding position on shore-lines opposite to it culminated in the joint undertaking of Britain and France in 1855 to guarantee the territorial integrity of Norway-Sweden (xv). Thus, was the alignment of the coastal peoples consummated. The undertaking was sum-

(xiii) A detailed study of British interest in Finmark has been made by Paul Knaplund. See "Finmark in British Diplomacy". American Historical Review. April, 1925, p. 478-501.

(xiv) Foreign Office Papers. 73. 184.

(xv) Paul Knaplund op. cit. also "Nye Oplysninger om November traktatens Forhistorie". Historisk Tiddskrift. Oslo. 5. R. VI.

marized by *The Times*, (December 19, 1855) as ". . . an insurmountable obstacle between that aggressive government and the object of its fondest desires — an access to the Atlantic Ocean never closed by ice, and within a few days' sail of the shore of France, England and Germany". Finmark, in itself, was neither of great commercial value nor strategical significance to Great Britain; but, as a base of operations for a continental power challenging North Sea mastery, it was a vastly different matter.

Activity on alternative fronts diverted Russian attention from Atlantic expansion until the critical period 1914-1918, when the latent tendency reasserted itself. The old phobia was revived in Scandinavia as Finmark became once more the focus of Russian efforts to escape from the cramped confines of continental seas. Norway, in general, and Finmark, in particular, became a coast of supply for Russia during the Four Years' War — Finland being transformed into a transit territory. Although trade was concentrated upon harbours with rail communication, sledge transport from the Atlantic ports assumed considerable proportions (xvi). Fig. I illustrates the more important sledge routes and links with Finnish railheads. Successful operation of Norwegian harbours as advance Russian outports in time of war was clear indication of their possibilities in time of peace. By this time, too, the iron ores of Swedish Lapland had reached a stage sufficiently advanced in exploitation to complicate the situation. A Russian reply to Scandinavian fears in 1916 posed the question — what is there in Norwegian fresh-water ports and iron ore which Russia does not possess already? Yet, it remains a fundamental reality that possession of the northern coasts of the

(xvi) c.f. "A Handbook of Finland", 1919. H. M. Stationery Office. p. 140-142. Over the Kirkenes route in the winter of 1916 as many as 150 sledges per day, each bearing a load of 1,500-2,000 pounds, carried cotton for use in Finnish factories.

Fig. III. Finmark as it appears in Andrea Bureo's "*Orbis Arctoi Nova et Accurata Delineatio*" (1626). Andrea Bureo, the father of Swedish cartography had travelled extensively in Scandinavia and had participated in frontier settlements between Sweden and her neighbours (Denmark and Russia) over the period 1606-21. This magnificent baroque copperplate has been recently published by the University of Lund, with a valuable text. (Edited H. Richter and W. Nordlind. Malmo. 1936). Powerful incentive was given to Andrea Bureo's work by the Arctic policies of Swedish imperialists.

Scandinavian peninsula is a *sine qua non* of a major Russian maritime development (xvii).

Changing human interpretation of geographical background over the last half century has modified the conception of Finmark. In the historical geography of this province, we are able to discern the operation of contending human forces and to appreciate the wider territorial relationships which influence its fate. Hence, apart from the influence of immediate environmental agencies which have promoted maritime development, the position of Finmark is governed by its situation relative to what Vilhjalmur Stefansson regards as the huge Mediterranean of the Arctic Ocean. The great "winter gulf of warmth", described by the isotherms, which modifies Finmark's climatic regime so favourably, makes it a unique territory on the circumference of the boreal Mediterranean which is interposed between the American and Eurasian continents. Pioneering in polar regions has given to Russia capacity to appreciate the value of Finmark. This power of the continental heartland possesses virtually complete command of the Arctic Coast of Eurasia. Finmark, probably the most important part of this coastline, lies outside its control. As a consequence of its geographical location, Finmark claims ability to control the gateway to Arctic Eurasia, i.e. to effect the exclusion of Russia from the Atlantic Ocean. The significance of the province as a base for strategical enterprise has not ceased to grow.

This is clearly illustrated in the latest chapter of Finmark's history. One power has reacted to the geopolitics of Norway. German occupation automatically brought Finmark under German control. Control of the North Sea coast of Scandinavia and interception of contact between the Baltic region and the World Ocean have been given added significance by control of Finmark. In the second place, Norway covers the north-east flank of Great Britain, its excellent harbours offering bases for naval craft. Finmark therefore assumes the function which Crow foresaw a century ago — although not as an advance base of continental Russia. In German hands, it is a menace to vital Anglo-Russian connections. Russian maritime trade routes to-day follow sixteenth century courses, and Germany controls the potential Gibraltar of the Arctic Mediterranean. It is the base for interception of convoys moving between the eastern and western theatres of war. Hence, Finmark offers a new position of eminence in North European relationships. Commando raids upon the remote northern littoral of the Scandinavian peninsula not only reflect allied importance attached to the approaches of this geo-

(xvii) See N.B. Emeljanoff, "Existerar den ryska Faran". Thule. 1916. The menace from the East and its meaning for Scandinavia is more fully and generally considered by Lucien Maury, "Le Nationalisme Suédois et la Guerre 1914-1918". Les Problèmes Scandinaves. Paris. 1918. The relationship of Germany is here considered freely.

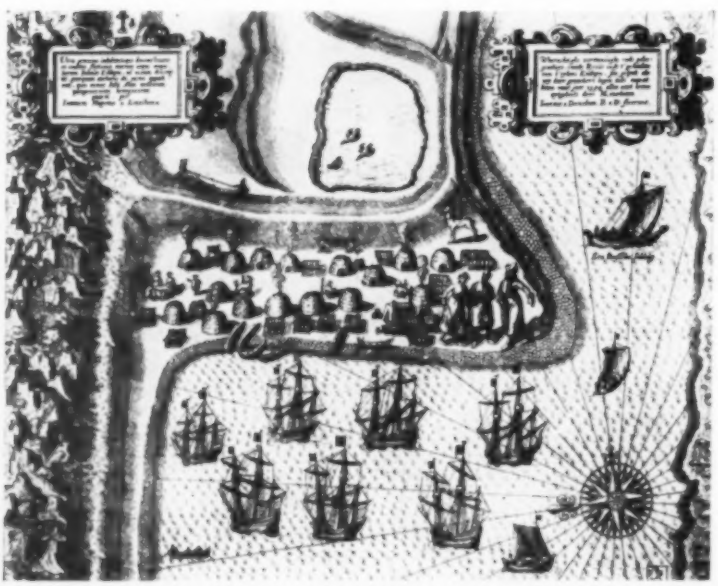

Fig. IV. Kildkyn — engraving of a typical Finmark settlement from the "Voyasie" of Jan Huyghen van Lindschoten. 1624. Notice the Russian merchantment. "While we lay at anchor" runs the Journal of King Christian IV "there came Russians on their way from Malmis to Gjommer who had no small quantity of sable skins, black and white amber, reindeer skins, Russian gloves and ermine."

graphically strategic province, they hint also that it is not under the sovereign sway of continental Germany. In the course of its historical evolution we can perceive the operation of fundamental geographical realities which relate the issue of Finmark immediately to the broad pattern of European events.

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Fig. V. A fair in Finmark from a woodcut in "Olai Magni Historien der Mittnächtigen Länder". J. B. Fickler. Basle. 1567. p. cxviii.

Fig. VI. The map appended to Pontoppidan's *Det Finmarkste Magazins Samlinger* distinguishes two administrative divisions — Eastern and Western Finmark. Alten was the principal focus of the western department and Vardhus of the eastern.

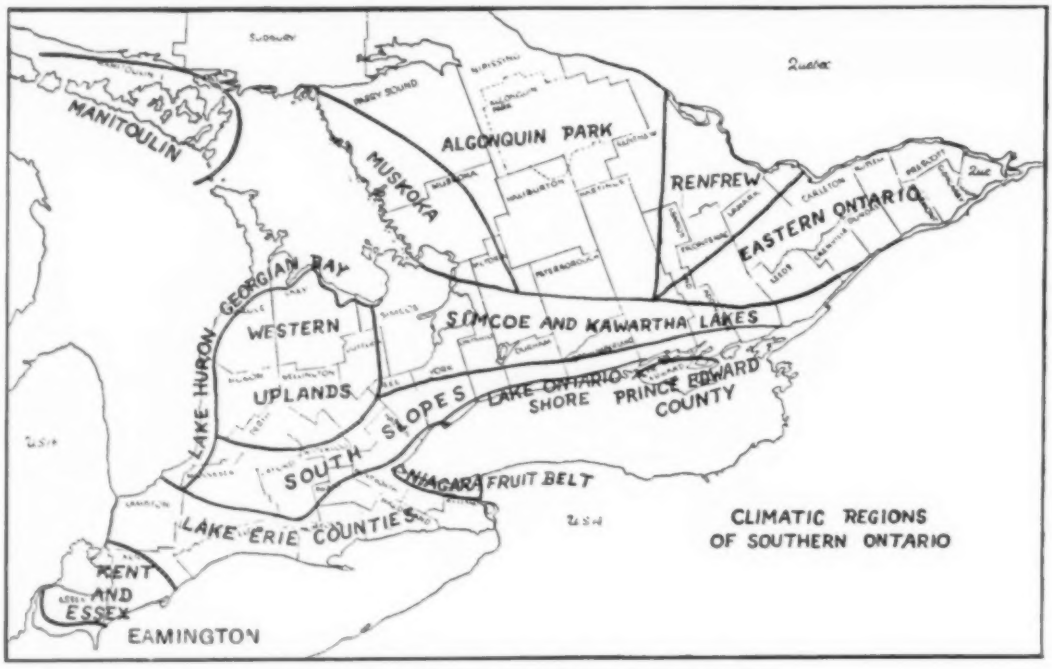

Fig. 1 CLIMATIC REGIONS OF SOUTHERN ONTARIO

The climatic divisions drawn on this map also delimit crop zones since climate sets the limits of plant survival. The Leamington area is the earliest and warmest section. Only two other spots in Canada, the Vancouver area and the southern tip of Nova Scotia, have milder winters. The Kent and Essex area has similar temperatures to the Niagara Fruit Belt, but extreme cold is lacking in the latter area. The Lake Huron and Lake Ontario shore-line areas are quite similar. The Western Uplands, especially in the highest part, are cooler in summer than Eastern Ontario where the temperature in January is several degrees lower. The coolest area, with the shortest season, susceptible to frost in any month of the year is around Algonquin Park.

ADAPTATION OF CROPS IN ONTARIO

by L. J. CHAPMAN

WHEN they cleared the land the pioneer settlers in Ontario cut the crop which was Nature's choice for that land. Then they began testing one domestic crop after another to see what could be grown to the best advantage. After a hundred or more years of experience in this matter, the zones in which main crops thrive are fairly well established, but, the last word is not yet said. Consider the fact that before 1921 there were no tobacco fields in Norfolk and adjacent counties along Lake Erie while last year it was a sixteen million dollar crop. In Oxford county during the past ten years there has been almost a complete change of oat varieties from late-maturing to earlier types. These two examples testify that the day of introducing new crops is not past and that opinion as to varieties of our common crops is not yet stabilized.

The selection of crops to be grown is governed by climate and soil on one hand and labour and market considerations on the other. While natural factors are fairly stable, the economic factors are constantly changing. For instance, if there should be an influx of immigrants to Canada after the war, it would bring about a rather drastic change of economy. In any event, it would be wise to collect and have available information about climate, soil, and yield and quality of crops grown in the various sections. In this way the double purpose of producing crops of quality and using the various soils to the best advantage will be fostered.

The climate of Southern Ontario has often been described in general terms, but seldom accurately defined. The growth of plants is governed by the length of day throughout the growing season, temperature, rainfall, humidity, amount of sunshine and the intensity of light. In order to give a concise account of these characteristics the area has been divided into

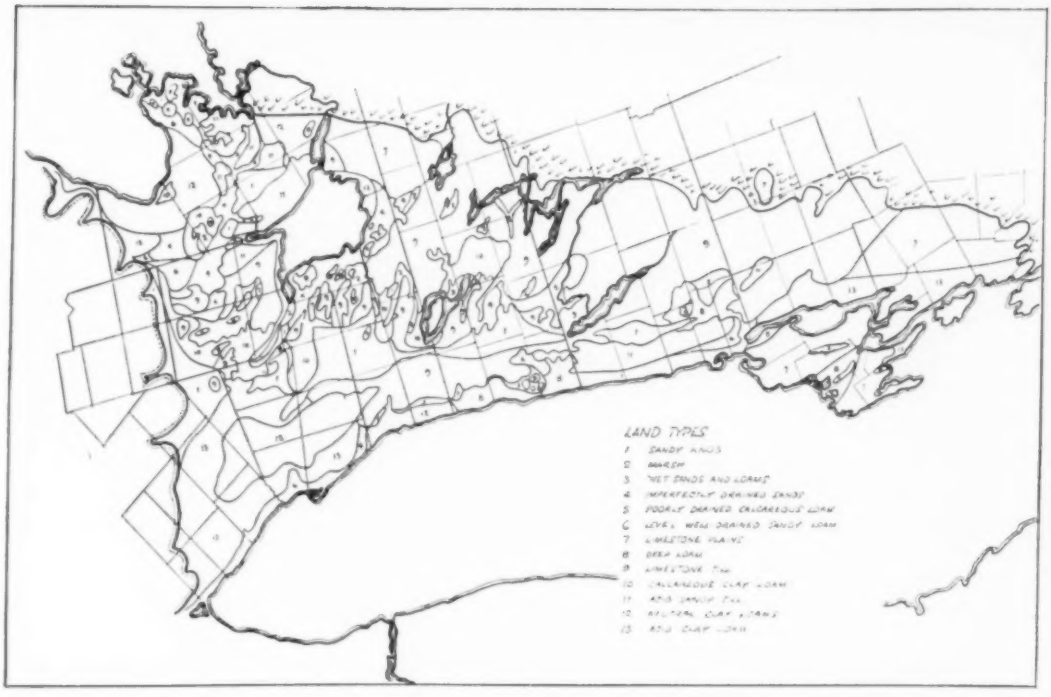

Fig. 2 A GENERALIZED SOIL MAP OF SOUTH-CENTRAL ONTARIO

The No. 1 type is a poor hilly sand, much of which should not have been cleared of woods. It supported fine stands of pine. Very little of the marsh is utilized; the Holland marsh where celery, onions, head lettuce, potatoes and carrots are grown is the notable exception. Some of the poorly drained sandy soils would be in better use if returned to forest. The No. 6 soil, west of Lake Simcoe is specialized to potatoes. On the No. 8 type are found some of the finest apple orchards in the province. The No. 10 soil is high in lime and low in phosphorus. Mineral supplements for live stock in this area should be low in calcium and high in phosphorus. No. 12 and 13 types are good alfalfa soils, but poor for potatoes or corn.

regions as in Figure 1, in which the climate is reasonably similar. The values for temperature, rainfall, drouths, frosts and other criteria are given in the accompanying Table I. The climatic regions shown on the map are crop regions as well since climate, in a broad sense, controls crop distribution. The boundaries were drawn only after having made charts showing the variation in each characteristic listed, that is, inches of snowfall, lowest temperature on record and so on. This map, together with a map of soil types, forms the basis for all crop adaptation work.

For several reasons it is not possible to present a soil map of Southern Ontario to parallel the climatic one. Such a map is not completed, and, if the information were in hand, it could not be shown on a small scale. A generalized map showing only a few inclusive types has a limited value, so a map of one section of the province only will be given as an example. Figure 2 is a generalized soil map of the district between Lake Ontario and the Laurentian border, with Table II giving the main characteristics of each.

TABLE II SUMMARY TABLE — CHARACTERISTICS OF SOIL TYPES

Type No.	Topography	Drainage	Stoniness	Reaction	Calcium	Phosphates	Potash	Original Forest
1	Hilly	Good	Few	Sl. Acid	Low	Medium	Very Low	Pine, Oak
2	Level	Poor	None	Variable	Low	Low	Very Low	Often treeless marsh
3	Level	Poor	None	Acid	High	Medium	Low	White Cedar
4	Level	Fair	None	Neutral	Low	Medium	Very Low	Pine, Soft Maple
5	Level	Poor	None	Alkaline	Very High	Low-Med.	Low	Soft Maple, Elm, Ash
6	Level	Good	None	Med. Acid	Low	Medium	Low	Pine
7	Level Undulating	Patchy Good-Poor	Stony	Alkaline	Very High	Low-Med.	Medium	Hard Maple, Beech
8	Undulating	Fair	None	Neutral	High	Medium	Medium	Sugar Maple, Beech
9	Rolling	Good	Stony	Alkaline	Very High	Low-Med.	Medium	Sugar Maple, Beech
10	Undulating	Fair	None	Alkaline	Very High	Very Low	Med.-High	SugarMaple, Elm, Ash
11	Rolling Hilly	Good	Stony	Acid	Low	Low	Low	Beech, Maple, Pine
12	Level or Undulating	Fair	Few	Neutral	High	Low	High	Elm, Ash, Maple
13	Undulating	Good	Few	Acid	Low	Very Low	High	Oak, Hickory, Pine

TABLE I.—REGIONAL CLIMATES OF SOUTHERN ONTARIO

Climatic Region	Leamington	Niagara Fruit Belt	Kent and Essex	Lake Erie Counties	Lake Ontario Shore	Prince Edward County	Lake Huron — Georgian Bay	South Slopes
Altitude	600′	250′–400′	600′–700′	600′–800′	250′–400′	250′–400′	600′–800′	600′–1000′
Mean Annual Temperature	48°	47°	47°	46°	44°	44°	44°	44°
Mean Winter Temperature	26°	25°	25°	23°	21°	20°	22°	21°
Mean Spring Temperature	45°	43°	44°	43°	41°	41°	40°	41°
Mean Summer Temperature	69°	68°	68°	67°	66°	67°	64°	66°
Mean Fall Temperature	51°	51°	50°	49°	48°	48°	48°	47°
Extreme Low Temperature	–20°	–16°	–27°	–34°	–30°	–33°	–35°	–39°
Extreme High Temperature	105°	104°	106°	106°	104°	106°	102°	105°
Daily Range of Temperature	17°	17°	18°	18°	17°	18°	17°	19°
Av. Date of Last Frost in Spring	May 1	May 8	May 8	May 10	May 11	May 15	May 15	May 15
Av. Date of First Frost in Fall	Oct. 15	Oct. 13	Oct. 10	Oct. 10	Oct. 3	Oct. 5	Oct. 10	Sept. 28
Av. Length of Frost-Free Period (Days)	167	158	155	153	145	143	148	135
Beginning of Growing Season	April 5	April 11	April 11	April 14	April 15	April 16	April 19	April 15
End of Growing Season	Nov. 7	Nov. 9	Nov. 4	Nov. 3	Oct. 29	Oct. 30	Nov. 1	Oct. 28
Av. Length of Growing Season (Days)	216	212	207	203	197	197	196	196
Av. Annual Precipitation	28.1″	30.9″	29.6″	33.8″	33.0″	28.6″	32.3″	32.6″
Average Annual Snowfall	32″	38″	46″	61″	60″	55″	95″	60″
Av. Rainfall April 1–Sept. 30	15.5″	15.7″	17.0″	17.1″	16.3″	13.9″	14.6″	17.6″
Av. Summer Rainfall (J.J.A.)	7.5″	8.6″	8.5″	8.8″	8.6″	6.7″	7.7″	8.7″
P-E Index (June, July, August)	10	11.5	12.0	12.5	11.0	9.5	11.5	2.5
Frequency of Droughts	30	30	20	20	25	34	22	20
Per Cent Possible Sunshine in Growing Season	55	55	54	54	54	54	48	50

Climatic Region	Simcoe and Kawartha Lakes	Eastern Counties	Western Uplands	Muskoka	Renfrew	Manitoulin	Algonquin Park
Altitude	600′–1000′	200′–400′	1000′–1800′	600′–900′	400′–800′	600′–1000′	100′–1400′
Mean Annual Temperature	43°	42°	42°	41°	40°	40°	39°
Mean Winter Temperature (D.J.F.)	18°	16°	16°	16°	13°	18°	12°
Mean Spring Temperature (M.A.M.)	40°	41°	41°	38°	39°	37°	37°
Mean Summer Temperature (J.J.A.)	65°	66°	66°	64°	65°	62°	63°
Mean Fall Temperature (S.O.N.)	46°	46°	46°	45°	44°	45°	43°
Extreme Low Temperature	–42°	–40°	–43°	–48°	–40°	–41°	–50°
Extreme High Temperature	104°	104°	102°	98°	103°	100°	103°
Daily Range of Temperature	19°	19°	19°	21°	22°	19°	23°
Av. Date of Last Frost in Spring	May 19	May 18	May 23	May 24	May 24	May 26	June 10
Av. Date of First Frost in Fall	Sept. 26	Sept. 26	Sept. 26	Sept. 24	Sept. 20	Sept. 30	Sept. 10
Av. Length of Frost-Free Period (Days)	130	131	126	123	119	127	93
Beginning of Growing Season (above 42°F.)	April 18	April 15	April 19	April 22	April 18	April 25	April 24
End of Growing Season	Oct. 25	Oct. 26	Oct. 25	Oct. 21	Oct. 23	Oct. 23	Oct. 17
Av. Length of Growing Season (Days)	191	194	189	182	188	181	176
Av. Annual Precipitation	30.4″	34.0″	36.0″	38.0″	31.0″	28.9″	35.0″
Average Annual Snowfall	76″	87″	100″	114″	80″	100″	90″
Av. Rainfall April 1–Sept. 30	15.6″	17.5″	17.5″	17.7″	16.7″	12.3″	18.2″
Av. Summer Rainfall (J.J.A.)	8.2″	9.2″	8.9″	9.1″	8.9″	6.3″	9.2″
P-E Index (June, July, August) (Pption effectiveness)	12.0	13.5	13.5	13.5	13.0	9.5	14.0
Frequency of Droughts (Less than 1″ of rain per Mo.)	19	9	18	10	15	33	18
Per Cent Possible Sunshine in Growing Season	52	52	45	50	50	52	50

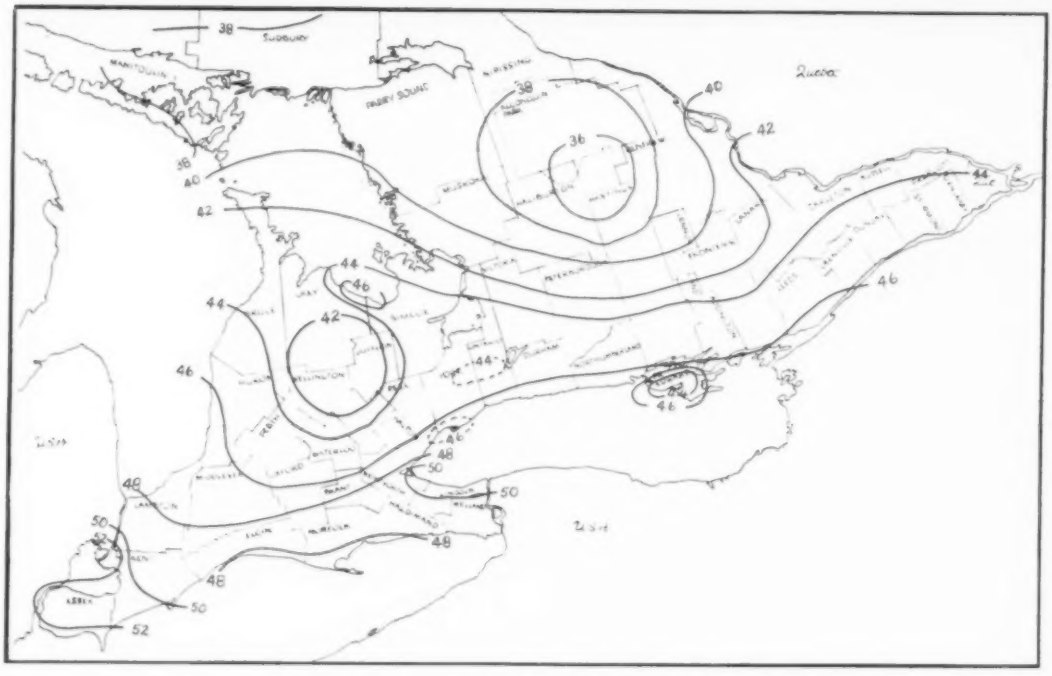

Fig. 3 THORNWAITE'S T-E INDEX FOR SOUTHERN ONTARIO

This index grades summer warmth. The figures are obtained by adding together the number of degrees that the several mean monthly temperatures are above the freezing point (32°F) and dividing by four.

It can be seen from this map that the Niagara Fruit Belt is not quite so warm as the Leamington-Windsor area. Eastern Ontario, although it has colder winters, is as warm in summer as a broad strip running right to Lake Huron.

There are great variations in the soil of this area. Running east and west through the centre is a ridge of poor, hilly, sandy soil in which blowsand is common. In the eastern part and north-east of Lake Simcoe there is shallow soil over limestone bedrock. Sandy, shallow, stony or marshy land makes up over thirty per cent of the total. On the other hand, about fifty per cent of the area has first class lands. These comprise the rolling, stony loams on the north and south slopes of the central ridge, and the level clay loams and sandy loams of the ancient lake floors in the Georgian Bay—Lake Simcoe and the Lake Ontario vicinities.

The outstanding chemical characteristic is the abundance of lime in much of this soil. The application of lime is not required for at least eighty per cent of the farms. The main acid soil areas are west of Toronto, where there is shale, and north-west of Lake Simcoe where the glacial till is mainly of material dragged southwards off the Precambrian Shield.

When dealing with a single crop it is usually necessary to describe climate in special ways. For the warm-weather crops such as tomatoes or soy-beans some index of the amount of heat received during the summer is useful. Figure 3 shows such an index. It depicts the gradation of summer warmth from Peelee Island to Algonquin Park.

Some recent tests in British Columbia on the quality of tomatoes indicated that lower temperatures and less sunshine gave rise to tomatoes poor in vitamin C. Since tomato juice is largely used as a source of vitamin C, this correlation between climate and quality ought to be investigated in all tomato-growing areas.

The Leamington-Chatham area is the major tomato-growing area in Ontario. Here there is the warmest climate and plenty of good clay loam soil. Heavy soil produces tomatoes having a darker red colour and fewer blemishes on the skin than sandy soil. Perhaps this area would produce an even higher proportion of the total crop if rainfall were more reliable. It is one of the drouthiest parts of Ontario. Some canning factories maintain their production along the north shore of Lake Ontario as a crop insurance measure. These two areas are over two hundred miles apart, and if tomatoes are a poor crop in the Leamington district there may be a better crop east of Toronto. The latter district has a frost-free period of

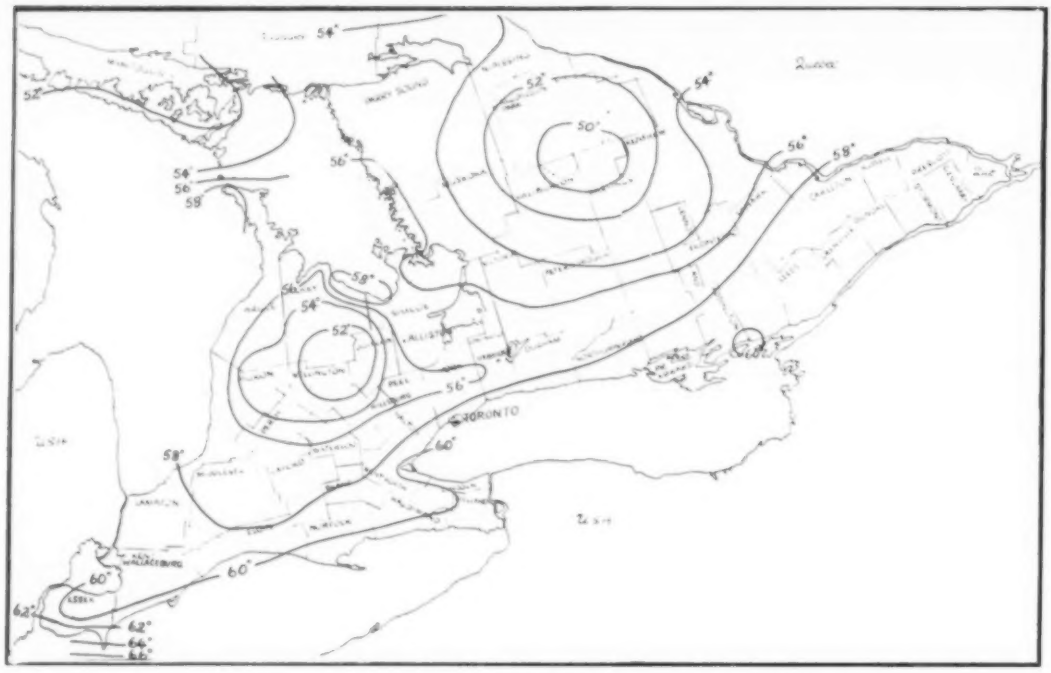

Fig. 4 AVERAGE DAILY MINIMUM TEMPERATURE IN JULY

Weather stations record the highest and lowest temperatures every day. The average of the thirty-one daily minima are shown on this map. It indicates the coolness of the nights in mid-summer. Outside of the Algonquin Park area Manitoulin Island and the uplands of Grey and Dufferin counties have the coolest summers in Southern Ontario. This map is intended to grade the climate as to its suitability to produce cool-weather crops such as peas.

barely 150 days. Tomatoes require at least 150 days, so it is just on the borderline in this regard, and sometimes there are losses due to frosts.

The MacIntosh Red apple is grown in the same part of the province as tomatoes, and it is interesting to note that the adaptation to climate is reversed in this case. A deeper red colour and firmer flesh are obtained in the cooler sections, such as east of Toronto, along the Georgian Bay shore, and also in Quebec. In the warmer south-west this variety ripens earlier when the temperature is higher and is, in fact, an autumn variety rather than an early winter variety. Moreover, the unfortunate tendency of MacIntosh apples to drop off the trees when nearing maturity is worse in the warmer climates.

Potatoes and peas are classed as cool-weather crops in Southern Ontario. Both find optimum growing conditions in the mountains of Colorado where the nights are always cool. Both prefer the climate of Northern Ontario or the Maritime Provinces to that of Southern Ontario. The quantity of Prince Edward Island potatoes sold on the Toronto market is evidence enough on this point.

The coolest farming sections of Southern Ontario are on Manitoulin Island and the uplands of Grey and Dufferin. This is well shown by Figure 4 which shows the average of the lowest daily temperatures recorded during July. It indicates the coolness of the nights in midsummer. Some potatoes are grown in Dufferin and Grey, more are grown in adjacent counties around Alliston, Hillsburg, and Uxbridge where there is fine sandy loam soil. This is a case of sacrificing some climatic advantage for the sake of better soil. Early potatoes grown in the Lake Erie section make use of the cooler forepart of the season and are harvested before the hot July temperatures occur.

According to expectations peas for grain are mostly grown in the cooler sections. On the clay soils of Renfrew county they specialize in peas for soup. However, green peas for canning are necessarily grown near the canning factories, which are located in the warmer zones where the majority of vegetables and fruits are adapted. Hot weather during the maturing period results in rapid and uneven ripening and co-incident loss of tenderness and flavour. A small quantity of green peas is grown in Nova Scotia, and processed in the lobster canneries on the north coast. Also, peas

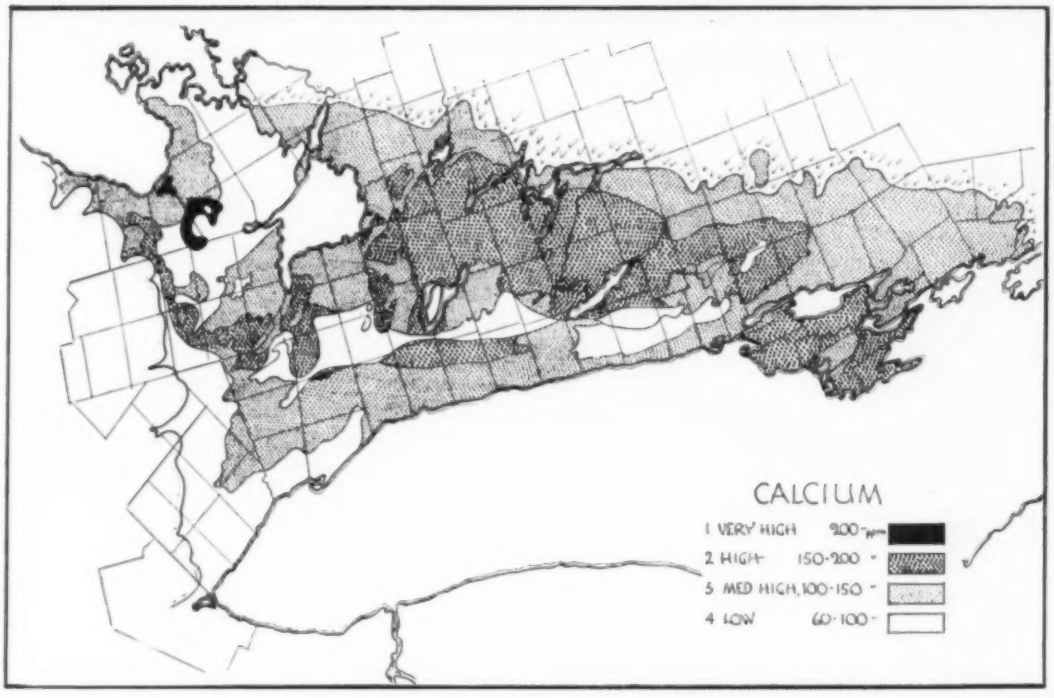

Fig. 5 AVAILABLE LIME IN SOUTH-CENTRAL ONTARIO SOILS

An acid soil is one that needs lime. No lime is needed on eighty per cent of the soils of this area. The underlying rock is limestone, except in the south-western part where there is shale. The shaly soil is acid, as is the soil north-west of Lake Simcoe which is developed from glacial material brought from the Precambrian Shield to the north.

Alfalfa is usually said to dislike acid soil as it requires an abundance of lime. The foremost alfalfa-producing section in Ontario is in Peel and adjacent counties, west of Toronto, although the dominant soils here are acid. It is a peculiar fact that alfalfa invariably thrives on shaly soils even though they are always acid. One can only speculate as to the cause of this association; perhaps it is due to the high potash contents of these soils.

of the finest quality are grown on the Gaspé coast where the climate is a little cooler than in the potato districts of Nova Scotia and Prince Edward Island. These peas are of the Telephone variety, and find a special late-season market in New York.

Just as special climatic criteria are calculated in studying certain crop adaptations, so selected soil characteristics may also be defined. The most valuable crop in Ontario is pasture. Hay and pasture combined occupy about half of all farmland. The nutritional qualities of pasture and other fodder crops are obviously important as these fodders form a large part of the feed of live stock. Deficiencies in soil minerals such as lime or phosphorus are passed on to the clovers or grasses and mineral deficiencies in live stock result. Milking cows pasturing on grass that lacks sufficient lime or phosphate become thin, have brittle bones, and stiffness in their joints. They are subject to digestive disorders and may become sterile. Their milk flow is reduced and it is inclined to be poor in cream. There are soils in Ontario low in both lime and phosphate, high in lime and low in phosphate or having various levels of each.

The amount of available lime and phosphorus in the soils of South-Central Ontario is shown graphically in Figures 5 and 6. Note the difference in the soils west of Toronto where they are derived from shale and east and north of this city where there are limestone soils. The shaly soils of Peel and Halton counties are low in both lime and phosphorus, while the limestone soils contain a superabundance of lime. The limy clay soils are phosphate-deficient, while the lighter loams and sandy loams are unusually well supplied. Incidentally, the soil of the famous Kentucky Bluegrass Bowl, which cradles the finest of thoroughbreds, is developed from the same parent rock, (Trenton Limestone).

A recent enterprise which serves to illustrate proper adaptation also deals with grass. A plant for dehydrating young cereal grass started operating last summer at

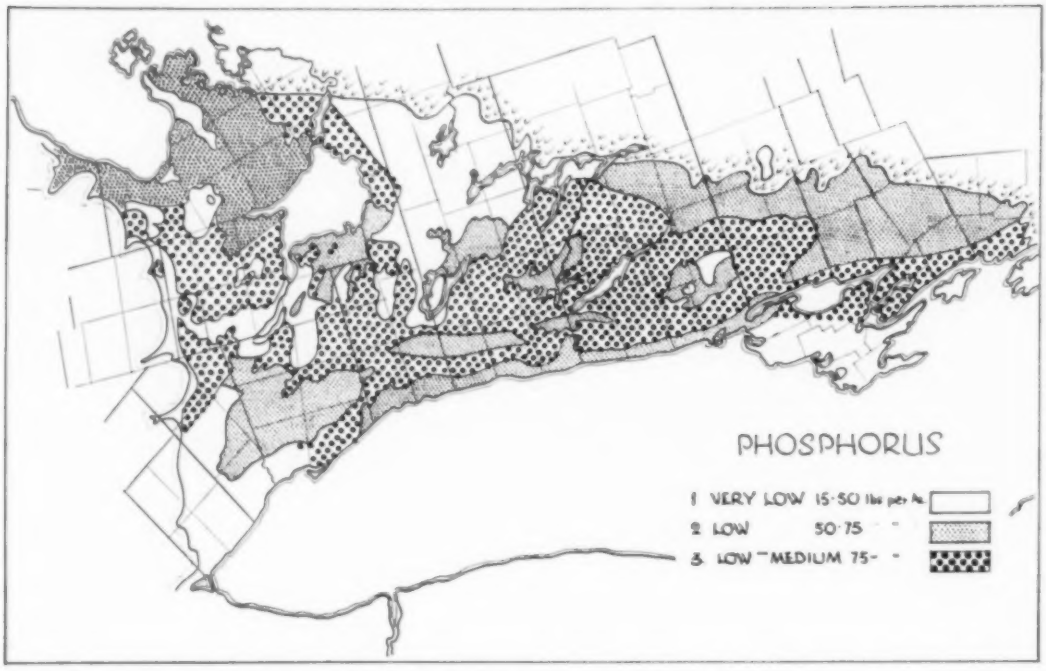

Fig. 6 AVAILABLE PHOSPHORUS IN SOUTH-CENTRAL ONTARIO SOILS

The lime and phosphorus of bones and teeth come from the soil. This element is most abundant in the sandy loams and most likely to be deficient in the clays. Ontario soils are generally lacking in phosphorus, although some are more deficient than others.

Wallaceburg in Kent county. The powdered product is used as a source of vitamins, minerals and protein in live-stock feeds, especially poultry feeds. Before locating this plant, samples were collected from selected spots across Canada. These were graded according to protein and vitamin A content, and the Kent county grass was found to be the best of the lot in these respects. Another attractive feature in the Wallaceburg vicinity was the level, stoneless soil because uneven or stony ground would be fatal to the large clipping machines used to gather the grass. The area also has the advantage of a long growing season which allows more cuttings than in a colder locality. The dry spells that frequently occur in Kent county are partly offset by the good water-holding capacity of the soil. Drouthiness is the chief limitation of this location.

In each of the foregoing instances the quality of the crop has been stressed. During the last few years particularly our concept of quality in a grain, fruit or vegetable has become more and more influenced by the nutrition chemist. The farmer and the plant breeder now consider mineral and vitamin contents in addition to the properties formerly required. If the farm fails to provide these essentials the drug store will be keen to serve with a capsule for every emergency. This adds to the complexity of the agriculturists task, but it also provides great prospects.

There are two ways of looking at the adaptation of crops. On one hand attention may be focused on efficient production of best quality crops, while, from another angle, we think of using soils to the best advantage. The use of land is governed by economic as well as natural conditions. A sudden increase in population would alter the cropping system on many farms. Specifically, certain abandoned farms might be settled upon and brought into cultivation. To cultivate some types of soil is merely to spoil them as forest soils. Surely we need not repeat the failures of a generation ago on poor land. We are well endowed with good soils. These offer a better opportunity both for returns from labour and for production of high quality crops.

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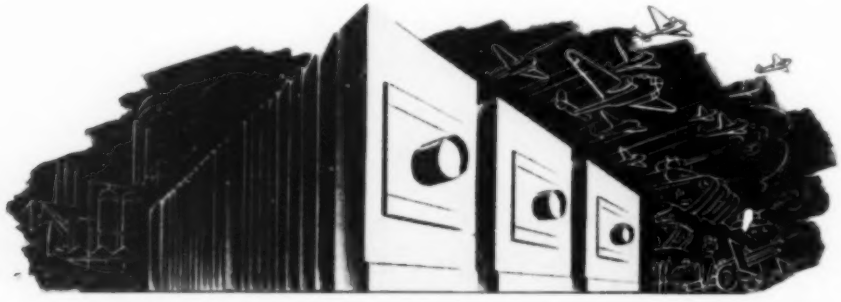
EDITOR'S NOTE-BOOK

A. G. Campbell's first association with guns was in England, the land of his birth. A keen student of this subject, his illuminating article deals with the historical development of guns of various types from the thirteenth century to the present day, guns of all calibres, and—starting from scratch—the part Canadian industry has played and is playing in providing front line troops of the Allies with an ever increasing flow of this all important war equipment. A past President of the Marine Club, Toronto, and associated for many years in the shipping business, Mr. Campbell was invited to come to Ottawa in December 1940, and he now holds the appointment of Assistant Chief, Army Gun Production Division, Department of Munitions and Supply.

W. R. Mead, now a member of the R. A. F., contributes in "Finmark" an informative and useful article in the European background series of articles which has been published in our Journal since the outset of World War II. The article is the result of several years' research including field notes made in Scandinavia. Following graduation from the London School of Economics (University of London) in 1937, the author proceeded with post-graduate work, obtained his M. Sc. degree (1939) upon submission of his thesis dealing with the commercial geography of Finland, and, for the next eighteen months prior to his entry into the R. A. F., was engaged in studies for a doctorate dealing with the geographical background to Scandinavian Unionism. A contributor to leading geographical journals, Mr. Mead is a Fellow of the Scottish Geographical Society and is associated with the Geographical Association of Great Britain.

Lyman J. Chapman, B.S.A., M.S., well-known to readers as the contributor of "The Climate of Southern Ontario" provides under the title "Adaptation of Crops in Ontario" a scientific approach to



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the right use of land. Illustrated with key charts, the author traces the hit-and-miss system guiding land use for the past hundred years with suggestions for planned economy and direction in the proper use of land and land settlement which experience and science would dictate as the only logical and sane approach in a planned economy for post-war years. Research Fellow on the Ontario Research Foundation engaged in an investigation of factors underlying crop distribution in the Province of Ontario, Mr. Chapman provides the fruits of many years of research in the field and laboratory following sound scholastic training in Canada and the United States.

AMONGST THE NEW BOOKS

International Boundaries by S. WHITTEMORE BOGGS, New York, Columbia University Press. Price $3.25.

This very timely book describes, discusses and analyses international boundaries in the various continents and the history, development and functions of a boundary. The author, Mr. S. Whittemore Boggs, is geographer to the United States Department of State, and, as such, has been able to make a special study of boundaries and the problems which are associated with them.

The book is admirably written and arranged and includes useful diagrams and illustrations and a comprehensive bibliography. Comparisons are given of the lengths of boundaries in various continents and the various types of boundaries: water, height of land, zonal boundaries in desert areas, and straight line boundaries are analysed and discussed, and the reader is given a lucid description of boundaries and their effect on mankind throughout the world. There is an excellent section on Canadian-United States boundaries and their related problems which is fully documented, and, an interesting comment on the effect of arbitrary boundaries on native tribes in Africa and on nomadic or pastoral peoples. The reader will be grateful for the omission of any hackneyed effusion on the thousands of miles of unfortified frontier between Canada and the United States which has, for so many years, been a well-worn topic for writers and orators on both sides of the International Boundary. The author, however, displays a tendency to place on international boundaries the onus for many of the restrictions to travel and trade which are, in reality, a reflection of the political and economic life of the nations themselves and in no way related to boundaries.

One finds throughout the book a certain atmosphere of transatlantic complacency which fails to understand European aspirations for an independent nationhood and the desire of ancient races to work out for themselves in freedom a way of life suited to their needs. It was not the multiplicity of boundaries which led to the present European tragedy but rather the desire of one nation to

(Continued on page XV)

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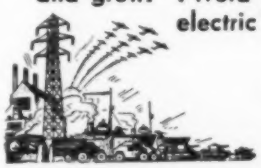

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(*Continued from page VII*)

dominate its neighbours who would have been only too glad to have been permitted to work out their destinies in peace.

The book is thoroughly readable throughout and is an outstanding example of the intensive studies of what might be termed political geography which are little by little giving us a better understanding of the problems of a world where distance has been annihilated by rapid transportation and where nations and continents are becoming more and more interdependent for essential raw materials. The book is heartily recommended to every student of world affairs.

The British Columbia Fisheries: by W. A. CARROTHERS. The University of Toronto Press, Toronto, 1941. Price $2.00.

This book is the tenth in the Political Economy Series issued by the University of Toronto Press. This series deals in general with the economic aspects of Canadian life and represents an invaluable contribution to our knowledge of the basic factors of Canadian economics. The present volume deals with the great fishing industry of the Pacific coast, and covers in detail its early history, the great expansion of the industry with the introduction of machinery and modern packing and storage methods, the depletion of the fisheries, and the various attempts to regulate and control the fishery, which were largely abortive, owing to private greed and international complications. The first seven chapters of the book deal with the salmon fishery, and include fishing methods, regulations, statistics of pack, the problems of marketing, and the effects of tariffs, foreign and domestic. The three last chapters in the book deal with halibut and other fisheries and with whaling and seal hunting. The latter is, perhaps, not strictly a fishery, but it has been so closely associated with the fishing industry of the West as to warrant its inclusion in the present volume.

The history of the British Columbia fisheries has paralleled that of so many of our natural resources, and has run through the cycle of expansion, depletion, and in the end, regulations, which, it is to be hoped, will, eventually, re-establish them on a reasonable scale of production and preserve for future generations this great industry and source of food supply. The book is a valuable study of an important subject and encourages us in the hope that, with a wider knowledge of the fundamentals of our economic life, the problem of the maintenance of our resources will receive the attention it deserves.

Essays In Transportation: University of Toronto Press, Toronto, 1941. Price $2.00.

This volume is Number Eleven of the Political Economy Series published by the University of Toronto Press, and dealing in general with the various aspects of the economic life of this country. It has been published in honour of W. T. Jackman, Professor of Transportation in the Department of Political Economy, University of Toronto, who has recently retired. Professor Jackman has long been recognized, both here and abroad, as an outstanding authority on railway transportation, and will be remembered as a strong opponent of the St. Lawrence waterway on which subject he has published many articles and papers in recent years.

"Essays in Transportation" includes an article by Professor G.P. deT. Glazebrook on "Nationalism and Internationalism on Canadian Waterways" which deals with the historical background of Canadian waterways and their influence on the life of the community. "Some Comparisons in Canadian and American Railway Finance" by Professor Herbert E. Dougall, provides the reader with some starling, not to say painful, information regarding the capital investment in Canadian railways and the continuous drain of railway deficits on the National treasury during the inter-war period. "Principal International and Interterritorial Class-rate Structures of North America" by Frank L. Barton, provides the reader with some clue to the basis of railway rates, which, to the public at large, has long been one of the great mysteries of the present day. Professor C. Lloyd Wilson has contributed an article on the "Basic Problems in the Public Regulation of Transportation", and Professor W. M. Drummond covers the field of "Transportation and Canadian Agriculture". "Some Problems of Urban Transportation" by Norman D. Wilson, Consulting Engineer of Toronto, presents an excellent and comprehensive study of a subject which, with current shortages of gasoline

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and rubber, is becoming more than ever of importance to the city dweller. "An Aspect of the British Railways Act, 1921" is treated in an authoritative article by W. G. Scott of the London School of Economics, and "Recent Developments in the Balance of International Payments Statistics" by Herbert Marshall covers an interesting aspect of statistical work. The book also includes a bibliography of the publications of Professor Jackman.

This book can scarcely be classed as one which would appeal to the general reader but it has a very real value to those interested in the economical structure of our country. The University of Toronto is to be complimented on the adequate manner in which their Political Economy Series is throwing the light of knowledge on the fundamental factors of Canadian economy.

P.E.P.

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Ancient England, by EDMUND VALE. (London: Batsford, 1941, 10/6 net).

It is with mingled feelings that one approaches books like this; grief that so much of our glorious English heritage is being ruthlessly destroyed and thankfulness that, while yet there was time, many priceless relics of the past have been preserved. For Captain Vale, in this book presents a survey of the ancient remains and monuments which have been preserved by H. M. Ministry of Works or purchased and cared for by the National Trust. "If churches have been bomb-gutted and famous buildings reduced to ashes, England possesses a wealth of ancient abbeys, castles and other monuments, many of them situated on lonely heights and remote valleys far from crowded towns." During the twenty years since the last Great War this nobly-conceived work has been carried on, excavating, preserving and restoring these historical documents, for, as has been said, the solid text of England's history is in fashioned masonry which speaks not only to the mind but to the heart because of its actual contacts with the men long gone.

Even if some of these incalculably precious relics of our island story should vanish, it is well that we should have this concise record written by an author who is peculiarly fitted for the task by his wide knowledge, extensive travel, and a vigorous and original outlook.

The book opens with an interesting chapter on types of ruins, and the methods of excavating, preserving and restoring them worked out by the Trust. There follow six sections, the first comprising prehistoric structures of the New Stone Age, the Bronze Age and the Iron Age; second, the Roman occupation, whose magnificence is reflected in monuments of a defensive and military character, except for the splendid ruins at Bath; third, the remains of the period from the withdrawal of the Romans to the Norman conquest, such as earthworks and crosses, Viking and Norman; fourth, Castles of the Normans, in the South Midlands and East Anglia, of the North and of Wales and the Welsh Border; fifth, monuments of religion, crosses of various types, memorial, boundary, market crosses, etc., abbeys, monasteries and monastic orders. The final chapter, the English house from Saxon times to the nineteenth century, will be to some readers most fascinating of all. This is the work of Mr. Harry Batsford who has made a masterly study of his subject. Travellers who have been stirred by glimpses of quaint half-timbered houses, little thatched cottages, and stately mansions in Renaissance, Jacobean and Palladian styles will enjoy a more intimate acquaintance with their structure and the famous architects who planned them. Nor are the gardens neglected, for much of the charm of the great houses came from their situation and surroundings. Mr. Batsford speaks feelingly when he says: "Perhaps one of the pleasanter compensations afforded by the war to those evacuated to strange districts for work and dwelling has been the opportunity of making the acquaintance of new historic houses, a high-lying stone hamlet, a great brick farmhouse and cluster of half-timber cottages down a wide green-margined side lane, four-square Restoration guest house, and a derelict Regency mansion brooding behind the wide stretches of its mournful park. Their makers and dwellers have put into them their own qualities, just the sturdy English cheerful matter-of-fact fitness which has enabled them to stand up to their job for a matter of some two to five centuries, will keep them in the same quiet usefulness for as long again, and will see us, some time, somehow, through the present war."

This enchanting book is richly illustrated by some one hundred photographs and drawings and a coloured frontispiece.